Divergent and convergent feedback: how science teachers conceptualise and practise oral feedback, and how students perceive it helps their learning

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Abstract

Feedback is frequently cited as an important practice in promoting student learning, yet reviews of research around written marking have concluded that the quality of existing evidence is insufficient to provide definitive answers as to what approaches are impactful. Even less is known about feedback during oral interactions, especially in authentic secondary science classrooms. This qualitative study examines oral feedback from both teachers' and students' perspectives, alongside an analysis of classroom practice. The study involved ten science teachers within two schools and 84 students interviewed from their classes. Comparative analysis resulted in the identification of teachers' conceptualisations compared to their classroom practice and a theoretically derived definition of feedback. Analysis of classroom practice was grounded in students' perceptions of what teachers said that helped them learn. This study makes an original contribution to knowledge regarding characteristics of oral feedback perceived by teachers and students to benefit learning in science. Following the analysis of 38 hours of lessons, three main types of oral interaction were found to constitute oral feedback: discrepancy and success criteria interactions, and open questions. Science teachers infrequently used these and were observed to utilise them in differing ways. This study has generated a theoretical ideal typical feedback framework, highlighting practical implications allied to teachers' differing practices, developed from Torrance and Pryor's (2001) model of assessment. The two ideal typical approaches to feedback are, the divergent approach, grounded in constructivist assumptions with students empowered to operate as *dynamic* co-agents; and the convergent approach, grounded in behaviourist assumptions with students acting as *passive* recipients. The study will be beneficial to teachers in reflecting on which aspects of their oral feedback practices are most likely to benefit learners in their classrooms, and policy makers and those involved in supporting educators to develop practices and nurture behaviours that promote student learning.

List of Contents

List of Tables

List of Figures

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Declaration

I declare that this thesis is a presentation of original work and I am the sole author. This work has not previously been presented for an award at this, or any other, University. All sources are acknowledged as References.

Chapter 1 Introduction and Study Overview

1.1 Chapter Organisation

This introductory chapter provides an overview of the research. The aims and personal motivations for undertaking the enquiry are presented. The background contextualisation and significance of the study are depicted and the research questions introduced. This chapter then concludes with an outline of the subsequent chapters of the thesis.

1.2 Aims of Study

Learning and feedback are inextricably linked; however, "what becomes very quickly apparent to anyone who seeks to understand feedback is that it is complex both conceptually and pragmatically" (Dann, 2018, p. 33). Feedback is often cited as having a large impact on students' learning (Black & Wiliam, 1998b; Education Endowment Foundation (EEF), 2017; Elliott et al., 2016; Hattie & Timperley, 2007; Kingston & Nash, 2011; Kingston & Nash, 2015; Kluger & DeNisi, 1996;). However, the majority of investigations reporting these potential learning gains are meta-analyses that have reviewed quantitative empirical studies (Black & Wiliam, 1998b; Elliott et al., 2016; Hattie & Timperley, 2007; Kingston & Nash, 2011; Kluger & DeNisi, 1996; Kulik & Kulik, 1998). Meta-analysis is a problematic approach for establishing anything meaningful as studies reviewed are highly reductive, and not necessarily comparative in terms of: quantitative vigour; pedagogical foci; attendant assumptions about learning; methodological approaches; data collected or ignored; an inadequate conceptualisation of issues involved (Black & Wiliam, 1998b) and outcomes are likely to be of very little use when applied to educational contexts (Dann, 2018).

A closer examination of these meta-analyses indicates that research findings are highly variable and even conflicting with both positive and negative gains associated with feedback being reported (Kluger & DeNisi, 1996; Shute, 2007, 2008). Consequently, to date we still lack clarity as to the effectiveness of feedback in improving learning (Dann, 2018; Elliott et al., 2016). If it is to become more useful for teachers and students, rather than focusing feedback research on empirical studies measuring 'how' feedback should be provided to a learner, feedback should be studied within authentic classroom contexts as part of the teaching process (Svanes & Skagen, 2016). Alongside this, feedback studies will be more effective if they link students' learning to teachers' teaching repertoires (Svanes & Skagen,

2016; Vercauteren, 2009) and are situated within a theoretical framework that "places greater attention on the cognitive processes that are involved in learning and on the social situation within which feedback is given and received" (Wiliam, 2018, p.1).

The lack of detail about how feedback supports students in their learning in the classroom may be a consequence of the students' perspectives being frequently missing from studies (Hargreaves, 2013; Murtagh, 2014; Poulos and Mahoney, 2008; Voerman, Meijer, Korthagen & Simons, 2012), as a result of studies that focus on pre- and post-intervention analysis rather than examining what happens in the classroom. Nuthall (2007) argues that by looking at teaching through the eyes of individual students, it can be revealed what they extract from experiences, the sense that they make from them and thus what helps them learn. Hargreaves argues that, "without the learner's perspective, the crucially important affective and interactional aspects of learner's responses to feedback are likely to be missing" (2013, p. 230). It was therefore the aim of this qualitative study to venture inside science teachers' classrooms and examine oral interactions and feedback practices to indicate oral feedback types and factors perceived to enhance the efficacy of oral feedback during teaching in promoting learning, by placing the learner at the centre of the study. This was accomplished by considering a theorisation of feedback derived from the literature, alongside teachers' conceptualisations and practices, and students' perceptions.

This research aimed to find out '*How science teachers conceptualise and practise oral feedback, and how students perceive it helps their learning'* by examining qualitative case studies of ten science teachers within two secondary comprehensive schools in the north of England. This involved interviewing all ten teachers twice, at the start and end of the data collection period, interviewing 84 of their students and observing and recording 38 hours of lessons in total, to analyse all of the oral interactions that occurred between the teacher and their students. For the purposes of this study oral interactions refer to any spoken communications that took place between the teacher and the students within the confines of the lessons. Oral - as opposed to verbal - is the term utilised by this study, due to 'verbal' meaning pertaining to 'words' that can be either spoken or written, whereas 'oral' relates only to 'speech'. A grounded theory approach was undertaken, with a combination of quantitative and qualitative methods used to analyse the data collected.

This study constitutes a significant contribution to knowledge about what occurs in classrooms, as UK secondary science classrooms are a previously unresearched context, particularly in relation to feedback. Teachers' perspectives have qualified the theoretically derived definition of feedback; in particular adding to ideas relating to teacher and student behaviours within the feedback process, and how likely these are to encourage/inhibit learning. From the analysis of students' perceptions, a number of different aspects of oral feedback practices have been identified as being perceived as helping their learning in science lessons. In particular, oral feedback types have been identified along with the intrinsic characteristics of *discrepancy* feedback in science. Furthermore, an examination of classrooms through the lens of student and teacher perceptions, generated a theoretical ideal typical feedback framework, indicating a range of practices associated with oral feedback, linked to the divergent and convergent framework of ideal typical approaches proposed by Torrance and Pryor (2001). Accompanying student behaviours were identified associated with *dynamic* and *passive* interactions, with the fundamental aspect being that of who did the thinking during the feedback. The study contributes not only to understanding of science classroom practice and teachers' and students' understanding of oral feedback, but provides insights that could inform policy and practices associated with feedback.

1.3 Rationale for this Research

1.3.1 Personal Motivation to Engage in this Research Area

As a teacher and foremost a mother of twins I have always been passionate about education and the advantages a research-informed teaching profession can offer every child as they move forward in life. I remember very clearly the first time I came across the term Assessment for Learning (AfL) and began to deepen my understanding of it, and the pedagogical approaches it entailed, including feedback, as processes that supported students' learning. It was just after I had started as a Science Educational Consultant working across a large local authority in the north of England in 2002. I was unaware during my time in school of the research summary that Black and Wiliam had published (1998a); however, on starting in my new role I was soon introduced to the work. I spent time reading and learning about some of the key aspects they explored, and was keen to see how it related to my beliefs about teaching, learning and assessment, and how I could draw on the research findings to benefit the broad range of teachers and schools I was supporting. From this early engagement with AfL, and the principles that underpin it, it became

evident to me that the strategies I had been utilising within my own classroom fell under the umbrella of approaches that were discussed.

During my time in school I held a number of different leadership positions across a number of different secondary schools. Throughout this period, I undertook a part-time Leadership Diploma with a local higher education institute in my spare-time. This started me on a personal learning journey and ignited my passion for my own professional development and for engaging in research literature and evidence in order to be in a more informed position, which subsequently is more likely to have an impact in both the relationships in which I engage and the work I undertake. Having completed the Leadership Diploma, and whilst working in the education authority, I undertook a part-time MA in Education which explored factors associated with effective professional development, specifically investigating a teacher network group and its level of impact on individual teacher's practice. During this time I moved jobs again and started at the then National Science Learning Centre in York, where I was in charge of developing the continuing professional development programme for science educators across the UK. Over time the work and team grew and I became the joint leader of a team of twenty staff who created and facilitated courses both at the physical centre and throughout the country. Throughout all of this time I continued to deepen my understanding of AfL and feedback and extend my thinking and practices by going into classrooms to teach, whilst also developing and facilitating professional development experiences for teachers and their students.

Having completed my MA, I wanted to become part of the research community that continued to support and serve teachers in the fast and hectic world in which they now find themselves operating, by conducting research within the field that I had been working in for over a decade. Consequently, I undertook research within the field of feedback, so as to add to the body of knowledge, to develop understanding and to support teachers and their students.

1.3.2 The Importance of Feedback

It is two decades since Black and Wiliam (1998a) published "Inside the Black Box" and introduced a generation of educators to the term 'AfL', and the ideas and concepts it encompasses, including feedback. However, as someone who works supporting teachers and other educators through the facilitation of continuing professional development experiences, I concur with the sentiments expressed by Black (2010); there are still many who are confused by the different purposes of

assessment and how to utilise feedback effectively to support learning. More recently, Eyers and Hill (2004) discussed how, from their analysis across the research into the feedback practices of New Zealand teachers, very little of the information gained from assessment was used by the teachers to provide feedback that supported the students in improving their learning. Alongside this they contend that teachers lacked clarity about the differences between instruction and feedback.

Eyers and Hill (2004) contend that despite the comprehensive professional development initiatives and the provision of literature designed to support and assist teachers in developing feedback strategies they remain resistant to change. They cite a number of reasons for why teachers' practices may be subtly but powerfully influenced, including: teachers' and school leaders' lack of subject and pedagogical knowledge; school and national assessments; appraisal and performance management policies; the pressure to report and meet standards. The educational landscape in England has continued to shift with a wide number of changes occurring such as: the dissolution of local authority support; the academisation of schools; curricular reforms, including the introduction of more challenging GCSE courses; increased aspirations of inspectoral bodies on school and student performance; re-introduction of grammar schools, the establishment of free schools, performance related pay; the removal of levels; and changes to the reporting of student performance, such as the introduction of 'Progress 8', to name but a few. Alongside this ever-changing landscape there is the continual pressure for schools and teachers to raise attainment outcomes for their students.

The Education Policy Institute (2016) reported that even though attainment is rising in England for both secondary and primary students (since 2005 GCSE average performance has gone up by just over half a grade, and primary students by approximately a fifth of a National Curriculum Level), there are still over 60 per cent of secondary and over 40 per cent of primary students failing to achieve their proposed world-class benchmark (75 per cent of secondary pupils to score 50 points or higher by 2030, the equivalent of a 'good pass' in all eight subjects that constitute Attainment 8 qualifications; at least 85 per cent of pupils to achieve a Level 4b or higher in reading, writing and maths at Key Stage 2 by 2025). The Education Policy Institute (2016) reports that with the introduction of more challenging GCSE courses, it expects the number of students achieving a good pass in maths and English to fall significantly, and show that there is a North/South divide as well as a considerable gap between disadvantaged students and their peers, with 80% failing to achieve the world-class standard at secondary.

Hargreaves (2012) analysed teachers' feedback practices in primary classrooms and argued that the historical and political influences of measurement-dominated learning objectives made by central government and its agents pressurise teachers into using convergent feedback approaches as a means of helping children to achieve prescribed targets. Hargreaves argues that this convergent use of feedback, which is by its nature from teacher to student, is used at the expense of opening up conversations between teachers and their learners, which would afford the students the opportunities to "exercise some critical agency in social contexts, formulate meaningful problems, make interesting enquiries or evaluate their own and others' impact on the world" (p. 13). Hargreaves suggests that rather than teachers utilising feedback to move students towards a target, a better question to consider would be how an interactive approach to feedback could support students' learning most appropriately.

Within this current education climate in England, three workload reform reviews were conducted as a response to the workload challenge that teachers currently face (Department for Education, 2016a; Department for Education, 2016b; Department for Education, 2016c). The areas considered by these reviews, where excessive workload was deemed unreasonable, were those associated with data collection and analysis, marking and planning. The Department for Education (2016b) asserts that all parts of the education system have a role to play in reducing the unnecessary tasks that take teachers away from their core task of improving the outcomes for the students they teach.

Black, Harrison, Lee, Marshall and Wiliam (2002) argued that, from their review of international research, enhanced formative assessment practices, including feedback would produce gains in student achievement, even when measured in such narrow terms as national curriculum tests and examinations. Clarke (2008) declared that formative assessment (and feedback) is a significant strategy in raising students' (or any learners') achievement. She argued that raising student achievement is such an important issue and a continual quest for educators, because raising achievement is inextricably linked with individual quality of life and economic growth. The link between educational achievement and quality of life is a line of reasoning that Wiliam (2011) presents. He contends that for individuals, higher levels of educational achievement mean higher earnings, better health and increased life span. Sadler (1998) also states that such practices are important for the individual. He argues that learners need to change their thinking to become more effective self-assessors, where self-assessment utilises feedback. He argues

that this is important for the learner, so they know not only how to respond to and solve (externally sourced) problems, but in addition how to frame problems for themselves; this, he argues, is a key skill for professional life. Wiliam (2011) goes on to argue that for society, higher levels of educational achievement mean lower health costs, lower criminal justice costs, and increased economic growth. In order to attain these increases in educational achievement, Wiliam (2011) attests that is by helping teachers become more effective, and in particular those that are already in the profession, as opposed to those entering it, or the removal of those that are ineffective, which is key. This he affirms is best accomplished through teacher professional development that focuses on how to develop minute-by-minute (i.e. within the lesson) and day-to-day (i.e. between the lessons) practices. Identifying such approaches in lessons affiliated with feedback is an aim of this study.

1.3.3 Can Classroom Feedback Improve Student Learning?

With education culture and schools changing considerably since the publication of Black and Wiliam's (1998a) initial study, the question remains whether AfL and associated practices such as feedback, still have a part to play in improving the practice of teachers, and the subsequent outcomes of students. Didau (2015) argues that even though many of the strategies postulated by Black and Wiliam have worth and the potential to have a positive impact on students' outcomes, the big idea that you can assess learning and respond usefully is wrong. The strategies Didau (2015) contests are the five key pedagogical approaches proposed by Black and Wiliam (2009), which include the use of feedback to support students' learning. Contrary to Didau's (2015) viewpoint is the work synthesised by Higgins, Kokotsaki and Coe (2011). In their summary of research evidence on factors improving student learning and attainment, Higgins, Kokotsaki and Coe (2011) have effective feedback as the number one strategy. Alongside this the EEF (2017) maintain that there is an estimated potential gain of eight months additional progress over the course of a school year that an 'average' student can expect if feedback is being used in school, the highest gains in learning of any implementation they review. However, the majority of the feedback meta-analyses from which EEF (2017) draw their inferences are not associated with oral feedback in science, are more than 10 years old, describe a variety of different outcome measures, with many reporting a wide range of different effect sizes linked to the studies evaluated. The picture then of what constitutes feedback interactions that support learning and work for students is not as straightforward and as clear as might be supposed.

It has become accepted by teachers and school leaders that feedback is a fundamental aspect of the teaching and learning process (Murtagh, 2014; Hattie and Timperley; 2007; Nuthall, 2007; Wiggins; 1997). However, Murtagh (2014) argues that despite the significance afforded to feedback and the assumption that it may have key benefits on learning, research in the field is somewhat scant. Murtagh (2014) cites several pertinent mega-reviews about feedback (Hattie & Timperley, 2007; Kluger & DeNisi, 1996; Mason & Bruning, 2001; Shute, 2007) and claims that even though much effort has been spent researching feedback, 'we still lack many details about how feedback helps children's classroom learning' (p. 517).

Similarly Elliott et al. (2016) undertook a systematic analysis of the research evidence available in order to inform teachers' decision making about feedback as marking. From the analysis they conducted, they concluded that there was a striking disparity between the amount of effort invested in marking and the very small number of robust studies that had investigated the use of written feedback in schools. As a result Elliott et al. (2016) recommended that there are areas about feedback which we simply do not know enough yet, and it would be valuable to investigate the most effective ways to use lesson time. Hargreaves (2014) claims that when it comes to research looking at how oral feedback can support learning in classrooms, the research evidence is sparse, as this is a difficult area to investigate. The reasons for these difficulties could be due to the fact that the students' learning takes place on many interrelated fronts, which makes it difficult to characterise, as well the learning being masked by other factors (Sadler, 1989; Sadler 1998). Indeed Elliott et al. (2016) stated, "no studies appear to have compared the impact of written dialogue to verbal dialogue and it is not clear why written dialogue should necessarily be preferable" (p. 18). Investigations into the aspects of oral feedback interactions that support and promote students learning are fewer than those conducted on the efficacy of written feedback, which as Elliott et al. (2016) claim are low in quantity and quality; all of this indicates that there is a definite need for more research into this important aspect of teachers' everyday practices, especially as small changes as to how teachers interact with their students during learning has the potential to make important differences.

In recent years the Ofsted inspection handbook has broadened out its criteria for evaluating the quality of teaching within a school from 'teaching' in 2014 to 'teaching, learning and assessment' in 2016, highlighting the increased importance and interconnectivity in the nature of teaching, learning and assessment. Within the inspection framework, Ofsted (2016) state that they

recognise that “marking and feedback to students, both written and oral, are important aspects of assessment” (p. 10). The grade descriptors they employ as indicators of outstanding practice include “teachers providing students with incisive feedback, in line with the school’s assessment policy, about what students can do to improve their knowledge, understanding and skills” (p. 48). They state that students should use this feedback effectively, explaining that this would be evidenced in classrooms by students who are eager to capitalise on opportunities to use feedback, written or oral, to improve their learning. Even though it is likely that the situation is similar across schools, secondary science classrooms remain an understudied context. However, no guidance linked to evidence is provided to schools or teachers, potentially leaving many teachers and leaders ill-informed and subsequently developing in-school policies and practices that may not always be conversant with research, which further exacerbate some of the pressures alluded to previously, such as excessive work load associated with marking.

There is a need to ensure that teachers’ use of feedback, especially oral feedback, is relevant and beneficial, and that teachers optimise the time spent in promoting learning for students. As noted earlier, there are strong arguments that feedback improves students’ learning. The further claims of its advocates of the positive benefits for the both the individual and wider society demonstrate why continued research in this field is valuable. It is therefore important to ascertain what oral feedback practices are currently utilised by teachers, and how these are perceived by students so we can continue to learn in order to develop classroom practices, which are beneficial to both educators and their establishments, but most importantly to their students. Chapter 2 will investigate research literature associated with feedback and examine the evidence associated with practices that have been proposed to help students make progress in their learning. This review will be used to construct a working conceptualisation of feedback for this study. Chapter 2 will also explore current areas of research and where deficiencies lie, to ensure that this study adds to the collective knowledge of the field by identifying where further exploration is needed.

1.4 Research Questions

The purpose of this study was to identify and analyse oral interactions undertaken between teachers and their students, which were perceived to operate as feedback. The research was guided by the key aim to explore:

'How science teachers conceptualise and practise oral feedback, and how students perceive it helps their learning'

The ensuing questions focused the research towards the similarities and differences between teachers' conceptions, their observed practice and a theoretically derived conceptualisation of feedback, as well as triangulating these against student perceptions in order to indicate potentially beneficial oral feedback types and practices.

1. How do science teachers conceptualise feedback and perceive their feedback practices including oral feedback?

2. What characteristics of oral feedback do science teachers perceive as improving learning?

3. I

4. To what extent and in what ways do science teachers' oral interactions compare to their conceptualisation of oral feedback and students' perceptions of what helps learning?

1.5 Overview of Study

This research study investigates science teachers' conceptualisation of feedback, in particular oral feedback during lessons, and compares these to a theoretical definition synthesised from research. Students' perceptions of oral interactions that support their learning are then examined alongside the synthesised definition from research and oral feedback types identified. Observation field notes and lesson recordings are collected across all teachers, and following the data collection period a comparative analysis is conducted using an analytical framework constructed from the data. The analytical framework is utilised to analyse recordings of every oral interaction undertaken between teachers and students, including oral feedback types. An examination is conducted of how teachers' operationalised oral feedback within their science classrooms, and this is explored in parallel with their initial perceptions and those of their students to identify practices and behaviours of interest.

The study is organised into seven chapters and this section offers a brief description of what is to be expected within each. The intention is to make this study easily accessible to the reader, as well as to provide some basic orientation through the overall research subject, by presenting a general overview of the structure and content. This first chapter presents the research background and motivation, defines the significance of the study and presents the research questions.

Chapter 2 reviews research literature associated with learning, especially learning theories and pedagogical approaches relevant to science to position this study. The link between learning, assessment and feedback is theorised with practical and theoretical implications presented, linked to two ideal typical approaches. A theorised conceptualisation of feedback is synthesised from research literature, which will be used to compare teachers' conceptualisation and students' perceptions as part of this study. Various dimensions of feedback are examined, as well as the roles and perceptions of teachers and students alluded to in the literature, including characteristics claimed to benefit learners. These will, in subsequent chapters, be examined alongside the features identified by the teachers and students who partook in the study.

Chapter 3 explains the methodology of the research, describing the theoretical backgrounds and methods adopted for the study. The use of the different research methods and data analysis process are justified and critiqued in terms of their efficacy in addressing the research questions. An evaluation of the study, including a detailed critique is presented alongside ethical considerations pertinent to the study.

Chapters 4, 5, and 6 present the findings of this research study, all of which are analysed against the theoretical conceptualisation of feedback derived in Chapter 2. Chapter 4 addresses research questions one and two, and reports the results of the interviews of the teachers and how they conceptualised feedback. This analysis highlights teachers' definition of feedback, the perceptions of how they realise oral feedback in their teaching space and characteristics associated with their classroom feedback practice repertoires. Chapter 5 addresses research question three by examining the data, which were collected from the student interviews. The chapter reports students' views and examines the results of what they perceive helped their learning in science, focusing in particular on aspects connected to oral feedback. Chapter 6 addresses research question four and reports the data that were collected from the lessons that were observed across all

of the teachers. The results are examined to reveal the extent to, and ways in which teachers interact orally with their students, focusing in particular on their use of oral feedback types. Teachers' practices are compared to the two ideal typical approaches, to highlight practical and theoretical implications related to oral feedback practices perceived to benefit learning, and those that are not. Finally teachers' conceptualisations are compared and contrasted with their classroom practice.

The concluding Chapter 7 discusses all of the findings of this study and offers contributions to knowledge, ultimately drawing on the results of the preceding chapters. In particular, findings in relation to previous research are examined, especially characteristics associated with oral feedback perceived to improve learning and linked to teacher and student practices and behaviours. Alongside discussions of the findings, implications for education professionals, those who support them and policy makers are discussed with evidence based CPD activities identified; as well as future research opportunities within the field and autobiographical reflections.

1.6 Chapter Summary

Having discussed the importance of feedback for both individuals and society, there is a need for science practitioners, those involved in establishing policy, and individuals supporting teachers, to be better informed as to aspects of authentic classroom feedback practices that have the potential to support learning. It is therefore the aim of this study to understand how oral feedback are still germane to today's science classrooms. The study will evaluate science teachers' perceptions and practices against a theoretically derived definition for oral feedback. Alongside this, students' perceptions will be analysed in order to indicate factors associated with oral feedback that do and do not benefit learning.

Chapter 2 Literature Review

2.1 Introduction

In order to contextualise this study and determine its aim and research questions, a review is conducted of literature associated with learning and feedback. The review outlines the literature on learning, learning theories relevant to science and aspects related to effective teaching in science. The interface between learning, assessment and feedback is examined, establishing the importance of feedback as a pedagogical approach within classrooms. Challenges exist in understanding feedback due to the complexity of the term; both conceptually and pragmatically (Dann, 2018, Hattie, 2008), resulting in no single definition agreed in the literature. Therefore, for this study a definition for feedback is derived from a cross-sectional analysis of the literature with criteria for the difference between feedback and non-feedback interactions established. The different purposes of feedback are analysed from the research, along with a number of different dimensions, including conditions, models and foci suggested as being associated with the effective implementation of it. The roles of both the teacher and the students within feedback that have been identified in research as potentially beneficial for the learner are then explored. The chapter will finally review investigations that have been conducted relating to written and oral feedback in order to highlight teachers' and students' perceptions along with areas where further research is required. The chapter will conclude by restating the aim of this study and the research questions to be undertaken along with the contribution that this research makes to the literature on oral feedback.

The following sections review the research literature pertaining to learning, learning and teaching in science and feedback.

2.2 Learning

The term *learning* has been conceptualised diversely as the "'acquisition of knowledge'; 'memorising and reproducing'; 'applying knowledge or procedure'; 'understanding'; 'seeing something in a different way'; 'changing as a person'" (Watkins, Carnell & Lodge, 2007,p. 10); a "'persisting change in human performance or performance potential', where performance potential implies that what has been learned may not always be immediately exhibited" (Driscoll, 2011, p. 36); "the development of one's understanding of the world and of oneself as a person" (Marton, Dell'Alba & Beaty, 1993, p. 201); and the "establishment of new

neural networks composed of synaptic connections and their associated chemotaxic patterns" (Howard, 2000, p. 59). Learning could be perceived to be one of these, a mixture or all of them collectively.

It is useful to consider effective learning in terms of both its outcome and its process (Askew & Lodge, 2000); where effective learning outcomes include: (1) deepened knowledge; (2) higher order skills, strategies and approaches; (3) action towards greater complexity and more learning; (4) positive emotions, excitement, enthusiasm; (5) enhanced sense of self; (6) more sense of connection with others; (7) further learning strategies; (8) greater affiliation to learning; (9) changed personal significance. On the other hand, processes associated with effective learning involve: (1) making connections about what has been learnt in different contexts; (2) reflecting on one's learning and learning strategies; (3) exploring how the learning contexts have played a part in making the learning effective; (4) setting further learning goals; (5) engaging with others in learning (Askew & Lodge, 2000; Watkins, Carnell, Lodge & Whalley, 1996). However, if we see learning as a virtuous cycle that is iterative, fluid and symbiotic with regard to both outcomes and processes then the distinctions between them decrease.

Another aspect alluded to and associated with some of the conceptions of learning presented above is that of performance (or achievement), where performance is the extent to which a student has achieved their short, medium or long-term educational goals. Such goals are often associated with procedural knowledge such as skills or declarative knowledge, such as facts, and present a limited view of learning with respect to the outcomes and processes listed above. Performance of learners is often measured through exams or continuous assessments. However, there is no consensus on how performance is best evaluated or which aspects are the most important (Ward, Stoker & Murray-Ward, 1996). Watkins et al. (2007) argue that there has been a misappropriated belief that performance is what learning in the classroom is all about. However, they emphasise that the relationship between performance and learning is far from simple and "better performance is not achieved by merely emphasising performance" (p. 45). Indeed, an individual can learn without any manifest improvement in their performance, whilst conversely there is the possibility that a person can perform well without deep understanding or long-term learning about a concept (Wiliam, 2018). My own performance and understanding associated with electric charge and electrical energy is testament to this notion. Having performed well in the topic throughout my educational career it was only when I started to

teach the topic that ideas began to link and I was able to construct a greater understanding. Learning is therefore complex, and the way that learners and teachers conceptualise learning, along with social, emotional and cognitive dimensions, as well as its immediate context, have a big influence both on what learners do, and how they go about their learning (Askew & Lodge, 2000; Watkins et al., 2007). Such complexities around the learning process indicate that many learning outcomes are not easily reducible to measures of performance.

Within the above listed conceptions of learning lie two broadly different perspectives. In the first, learning is seen as coming from the outside of the learner and something that is given. In that sense, it is a teacher-led activity with the teacher being in control. This perspective of learning aligns to more traditional behaviourist theories, whilst the converse perspective sees learning as coming from inside the learner, with information actively processed and constructed inside their mind by them, and as such aligns to the more progressive constructivist perspective (Bates, 2016; Buhagiar, 2005; Marton, et al., 1993).

However, conceptions of learning are developed further by considerations of how learning is thought to occur. Driscoll (2011) states that learning occurs as a consequence of how the learner experiences and interacts with the world. Indeed, Brown, Collins and Duguid (1989) state that what is learned cannot be separated from how it is learned and used. They argue that activities, through which knowledge is developed and deployed, are not separable from or ancillary to learning and cognition. Nor, they say, is the activity in which a learner engages to develop knowledge and use it neutral. Rather, the activity is an integral part of what is learned, and in that sense learning and cognition are fundamentally situated learning, in the environment in which they occur.

Throughout the literature a number of features associated with effective learning are presented that are argued enable students to be better placed to create meaning and develop schema (mental models); aspects of learning that have particular cogency in science (Harrison, 2015; Harlen et al., 2015; Kapon, 2017; Leach & Scott, 2003). These common features of effective learning involve students: (1) acquiring and recalling knowledge (Bates, 2016; Hargreaves, 2016; Howard, 2014; Nuthall, 2007; Schwartz, 1980; Watkins, Carnell, Lodge, Wagner & Whalley, 2002, Watkins et al., 2007); (2) actively constructing meaning (ASHE-ERIC, 1986; Bates, 2016; Hargreaves, 2016; Nuthall, 2007; Schwartz, 1980; Watkins et al., 2002, 2007); (3) collaborating (ASHE-ERIC, 1986; Bates, 2016;

Hargreaves, 2016; Howard, 2014; Nuthall, 2007; Schwartz, 1980; Voerman, Korthangen, Meijer & Simons, 2014; Watkins et al., 2002, 2007); (4) taking responsibility for their learning through increased learner autonomy (ASHE-ERIC, 1986; Bates, 2016; Hargreaves, 2016; Nuthall, 2007; Schwartz, 1980; Watkins et al., 2002, 2007); (5) reflecting and evaluating their learning, where the reflecting and evaluating of learning is often referred to as meta-learning (ASHE-ERIC, 1986; Bates, 2016; Hargreaves, 2016; Nuthall, 2007; Schwartz, 1980; Watkins et al., 2002, 2007).

In an attempt to produce a definition that draws out key elements which has individual and social implications for learners in informal school environments, Watkins et al., (2002) define learning as:

> *The reflective activity which enables the learner to draw upon previous experience to understand and evaluate the present, so as to shape future action and formulate new knowledge. (p. 1)*

In order to portray the complexity of the learning process, Watkins et al. (2002) proposed a fluid model which links to constructivist perspective of learning (see Section 2.3). The model shows how the prior experience and knowledge of the learner, the context of the learning, the teachers' conceptions, and the teaching-learning processes, along with student outcomes, affect and influence the process of learning (Figure 2.1).

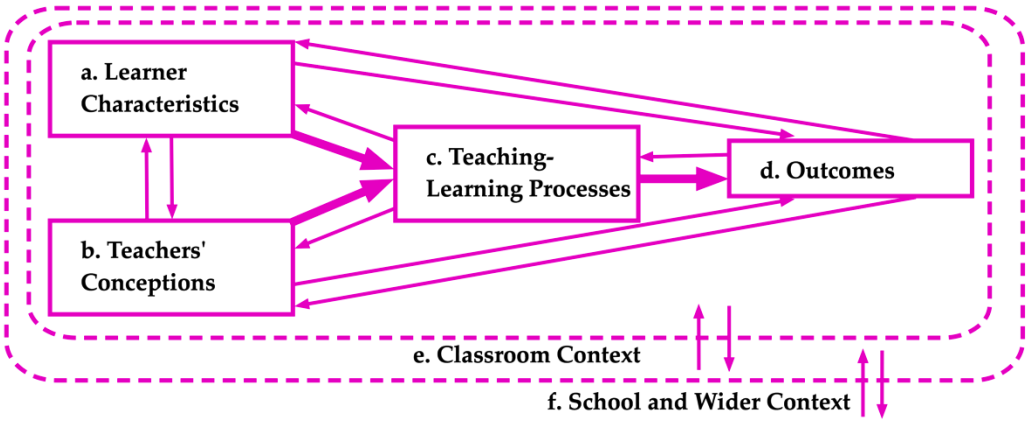


Figure 2.1 A contextual model of school learning, Watkins et al. (2002)

The model tries to portray the complexities and interdependence of a range of different factors that can influence the learning process, and in that sense aims to

show that learning is not linear or indeed predictable for any student, but rather that 'effective learning can be seen as a virtuous cycle' (p. 4).

Within this contextual model of school learning there are aspects that are relevant to the scope and aims of this study; namely, how the learner and teacher interrelate with each other during classroom interactions and the role that feedback, including oral, may play, along with any impact that these occurrences are perceived to have on learning. The nature of teachers' and students' roles as they interact and how they align to the research definition of feedback, including oral, will be considered in light of the literature in the upcoming sections of this chapter.

Nevertheless, learning and teaching are separate processes that can occur independently of each other. Indeed, individuals can learn without any engagement with a teacher, from encounters such as books, experiences, relationships, and even their own thoughts (Nuthall, 2007; Schwartz, 1980). Schwartz affirms that "how students learn and teachers teach are complicated processes, difficult to understand and even harder to master" (1980, p. 235). The notion of teaching and learning being linked but different concurs with the idea of *studenting* as opposed to *learning*, argued for by Biesta (2015). Biesta (2015) contends that there is a "significant degree of confusion in discussions about learning stemming from using the word both to refer to an activity and the result of the activity" (p. 232). Biesta (2015) argues that the act of teaching should be referred to as *studenting*; this is defined as the teacher serving the learner through the creation of learning opportunities and by acting as a primary source of knowledge, with the outcome of the act of *studenting* described as learning.

2.2.1 Purposes of Learning

Alongside the features of learning listed above, Hargreaves (2016) proposes four pillars of a life-long education espoused by UNESCO (1996) as the various purposes of learning. These are: (1) learning to know, through the acquisition of knowledge and an understanding of how to learn; (2) learning to do, by developing competencies and skills enabling learners to be successful in various settings and teams; (3) learning to live together; via an appreciation of other people and respect for the values and pluralism in and across societies; (4) learning to be, by being empowered to act with greater autonomy, judgement and personal responsibility.

UNESCO (1996) states that formal education systems tend to emphasise the acquisition of knowledge, learning to know, as the main purpose of learning; this, UNESCO states, is to the detriment of the other purposes of learning. The

dominance of practices associated with the acquisition of knowledge across all phases of education, is a viewpoint with which others concur (Askew & Lodge, 2000; Hargreaves, 2012; Watkins et al., 2002). Watkins et al. (2002) describe the acquisition of knowledge as the most common form of practice adhered to in classrooms, and that these practices link to the belief that students learn by being told. The practice of telling students in order for them to amass knowledge most closely aligns to the behaviourist input-output process of learning. However, Watkins et al. (2002) argue that this belief is insufficient to account for the complex learning processes which need to be promoted in classrooms; indeed they go on to challenge this perception by quoting Mark Twain saying that "if teaching was as simple as telling, we'd all be a lot smarter than we are" (p. 3).

UNESCO (1996) states that making sense and meaning are skills that are a prerequisite for life-long learning if students are to meet the challenges of living and flourishing in the rapidly changing world they find themselves growing up in. Gilbert (2011) explains that with the democratisation of knowledge arising as a consequence of the technical revolution that has occurred towards the end of the twentieth century, the role of the teacher is seen as no longer as being about the transmission of knowledge. Indeed, where effective learning occurs, Gilbert (2011) argues that the role of teachers is to empower students to be able to not only acquire knowledge but to be able to evaluate its quality, use, apply and synthesise it; a process he terms as the democratisation of learning.

The purpose of learning in the current educational climate in the UK has the potential to align in principle to constructivist rather than behaviourist approaches. However, due to a large number of pressures on schools and teachers, such as: the breadth and depth of curriculum coverage needed; performance management regimes; school performance data; high stakes testing and other accountability measures there is the possibility of teachers defaulting more often to the behaviourist, input-output, teacher-to-students acquisition and use of knowledge approaches to learning. This however, has the potential to be a less effective learning experience for students who require an education that provides them a passport to lifelong education (UNESCO, 1996) if they are to proceed and be successful learners throughout their life.

This review of the literature indicates what is already known about the roles required by both teacher and student as they collaborate in the learning process; namely, that in the behaviourist approach to learning the teacher is the 'giver' whilst

the student is the ‘passive recipient’ of the knowledge, whereas in the constructivist approach the teacher is the ‘engineer/facilitator’ of the learning, providing students with meaning-making opportunities at points appropriate to them, as they construct understanding, and in this sense the student acts more ‘dynamically’ in the process as co-owners of their learning. The roles the teacher and students assume during interactions will be explored further in relation to the literature pertaining to feedback in sections 2.8 and 2.9.

In order to position the study the following section will examine two broad strands of learning theory that have been drawn upon in science education literature. Aspects of both learning theories will subsequently inform the understanding of teaching and pedagogical approaches, such as feedback, that can support learning in science in formal settings such as secondary school classrooms.

2.3 Learning Theories Relevant to Science

Learning in science is about making sense of phenomena or events that we encounter in the world around us, with the difference of learning science in comparison to other subjects being in the consideration and testing of evidence (Harrison, 2015; Harlen et al., 2015; Kapon, 2017; Leach & Scott, 2003). Learning in science draws on a number of different learning theories. The two main strands of learning theory underpinning the conceptualisation of learning in science are cognitive and sociocultural constructivist theories. James (2006) argues that paradigm purists might argue that, like oil and water, it is not possible to mix different theories; they may assert that a theory, if it is a good theory, attempts to provide as complete an account as possible of the phenomena in question. Therefore, James (2006) argues that one good theory should be sufficient. However, she acknowledges intricacies associated with respect to the complex and wide field of study that is teaching and learning. This means that if the set of phenomena is drawn slightly differently, as it can be, then it is reasonable to expect a number of theories to subsequently overlap. Agarkar and Brock (2017) also argue that the conceptualisation of learning drawing on multiple models “may be more flexible and powerful than adherence to a single dominant approach” (p. 101), therefore affording teachers the opportunity to cope with the diversity of classroom situations.

Both cognitive and sociocultural constructivist views of learning are based on an interpretivist epistemology, where the central endeavour is to understand the subjective world of human experience from within (Cohen, Manion & Morrison,

2008). Although science educators approach the teaching of the subject from the perspective of one who has developed the appropriate level of subject knowledge and has an understanding of the phenomena being examined, learners in science, however, need to engage in an on-going complex process in which they construct and reconstruct a series of self-explanations that evolve, change and replace one another or merge into a new self-explanation, with teachers facilitating the process (Agarkar & Brock, 2017). Students need to be able to understand from within the world around them, as they will need to utilise science ideas and models about phenomena in multiple contexts (Kapon, 2017; Leach and Scott, 2003). Both theories, and how they link to science learning, will be explored in the following sections.

2.3.1 Cognitive Constructivism

Cognitive constructivism stems from the work of Piaget (1955) and his beliefs that learners construct knowledge based on their individual experiences as they progress through various steps, whilst moving along a continuum from sensory motor level understanding to the construction of intelligence. Howard (2014) argues, “the mountain range of research data generated in child development has wreaked havoc on [Piaget’s] linear stage model” (p. 91). As a rebuttal to the stage-based model, he argues that children have been shown to begin learning a particular task earlier and using multiple strategies that were formerly thought to appear at different stages. Shayer (2003) concurs, stating that the range of cognitive abilities across a school year group is far, far wider than perceived, indicating that even at the same age students’ capabilities vary.

However, there are still aspects of Piaget’s theory that are relevant. Bruner (1999), when discussing the readiness for learning of children, explains that the intellectual development of a child is not a clockwork sequence of events; rather it is influenced by external factors, a view which agrees with Piaget (1955), who claimed that learning experiences are influenced by a number of factors associated with the learner, including their emotional, biological and mental stages of development. Bruner (1996) explains that what all of the research in the subject has in common is an effort to understand how children themselves organise their own learning. This involves cognitive processes such as: remembering, guessing and thinking (Bruner, 1996; Nuthall, 2007). Bruner (1996) continues that “unlike older psychological theories, bent on imposing "scientific" models on children's cognitive activities, this work explores the child's own framework to understand better how they come to the views that finally prove most useful to them” (p. 58). The object of the study,

according to Bruner, is the child's *own* folk psychology; where folk psychology is concerned with how the mind works 'here and now', along with how it learns, and grows. Understanding the pre-instructional knowledge students bring to a given teaching situation is of particular importance for educators when helping students construct learning in science. Leach and Scott (2003) argue that cognitivist views of learning theory portray science learning "fundamentally in terms of changes in the 'mental structure' of individuals" (p. 92) which they refer to as *individual views on learning.*

James (2006) explains how cognitive constructivist theories of learning require the learner to be actively engaged in the learning process, and states that a determining factor of the theory is what is going on inside people's heads. James (2006) asserts that as these theories are associated with 'cognition', they are mostly interested in 'mind' as a function of 'brain'. With regards to how learners construct meaning and make sense of the world, James (2006) contends that this is achieved through organising structures, concepts and principles in schema. James (2006) contends the following aspects of learning could be associated with a cognitive constructivist approach: (1) being aware of the prior knowledge of a student, as this is seen as a powerful determinant of their capacity to learn new material; (2) an emphasis on 'understanding' (and eliminating misunderstanding); (3) constructing knowledge through the use of problem solving; (4) developing processing strategies, such as deductive reasoning from principles and inductive reasoning from evidence; (5) notable differences between how experts and novices organise knowledge in structures in order to be able to retrieve and use it; (6) achievements gained through understanding in relation to conceptual structures and competence in processing strategies in order to achieve; (7) the two components of metacognition - self-monitoring and self-regulation – as important dimensions of learning. Self-monitoring is one of three sub-processes associated with self-regulation/self-regulated learning, with the additional sub-processes being *'performance monitoring'*, and '*reaction and reflection'* (Wigfield, Klauda & Cambria, 2011). Where self-regulated learning is defined as an active constructive process involving self-generated thoughts, feelings, and actions that are planned and cyclically adapted to the attainment of personal goals (Boekaerts, Pintrich & Zeidner, 2005; Koriat, 2012, Nicol & Macfarlane-Dick, 2006).

Watkins et al., (2007) concur that the learner needs to be active in the learning process. However, they explain that the learning - 'meaning making' - can either be constructed by the individual working on their own, or co-constructed by

creating knowledge through engagement with others. Strategies that Watkins et al. (2007) argue form part of either of these approaches can be seen in Table 2.1.

Constructional Model – Individual Sense Making	Co-construction Model – Creating Knowledge with Others
• Students are engaged in active participation, exploration and research. • Students are engaged in activities to develop understanding and create personal meaning through reflection. • Student work shows evidence of conceptual understanding, not just recall. • Students apply knowledge in real world contexts. • Students are presented with a challenging curriculum designed to develop depth of understanding. • Teacher uses diverse experiences of students to build effective learning. • Students are asked by the teacher to think about how they learn, explain how they solve problems, think about their difficulties in learning, think about how they could become better learners, and try new ways of learning. • Assessment tasks are performances of understanding, based on higher order thinking.	• Students operate together to improve knowledge. • Students help each other learn through dialogue. • Learning goals emerge and develop during enquiry. • Students create products for each other and for others. • Students access resources outside the class community. • Students review how best the community supports learning. • Students show understanding of how group processes promote their learning. • The classroom social structures promote interdependence. • Students display communal responsibility including the governance of the classroom. • Assessment tasks are community products which demonstrate increased complexity and a rich web of ideas.

Table 2.1 Activities associated with students making meaning

From this analysis the active engagement of learners as agents in their own learning, drawing on the range of aspects suggested (James, 2006; Watkins et al., 2007), as they construct meaning, links closely to the conceptualisation of learning in science suggested previously. As such cognitive constructivist learning theories have agency when considering the pedagogical approaches utilised in the teaching of science. Leach and Scott (2003) however, contest that aspects associated with students' own cognitive constructs are not enough to explain how students learn in science classrooms, and stress the importance of the social environment within in which students find themselves encountering scientific ideas.

2.3.2 Sociocultural Constructivism

Making meaning in science is embodied by a social constructivist view of learning, as it involves students interacting with their peers, adults and society in order to develop their understanding in the subject and to develop an appreciation of the nature of scientific activity (Agarkar & Brock, 2017; Harlen et al., 2015; Harrison, 2015; Kapon, 2017; Scott, 1998; Leach & Scott, 2003).

Vygotsky (1978) saw social learning as a precursor to development; that is, learning is seen as a social process that arises as a consequence of human interactions and these play a fundamental role in the development of cognition.

> *An interpersonal process is transformed into an intrapersonal one. Every function in the child's cultural development appears twice: first, on the social level, and later, on the individual level; first, between people (interpsychological), and then inside the child (intrapsychological). (Vygotsky, 1978, p. 57)*

This sociocultural constructivism, Vygotsky (1978) contends, is the origination of human intelligence in society or culture. Vygotsky (1978) argued that as well as socially constructed cognitive understanding there was another element at play in relation to learning and development. This, he claimed, is linked to the *Zone of Proximal Development*. Vygotsky (1978) defined the *Zone of Proximal Development* as the distance between where the child's actual developmental level would be if they undertook problem solving on their own, as opposed to the level of potential development they could achieve through problem solving under adult guidance or in collaboration with more capable peers, often referred to as the more knowledgeable other (MKO). Wood, Bruner and Ross (1976), when discussing problem solving for a learner, concur that if the social context is taken into account, then by working with a MKO the learner engages in a "kind of 'scaffolding' process" (p. 90) that enables them as a novice to solve problems, carry out tasks or achieve goals which would be beyond their unassisted efforts. Wood, Bruner and Ross (1976), argue that scaffolding is much more than the teacher modelling and the learner just imitating. They argue that scaffolding "consists essentially of the adult 'controlling' those elements of the task that are initially beyond the learner's capacity, thus permitting them to concentrate upon and complete only those elements that are within their range of competence" (p. 90). This social scaffolding of learning therefore, has the potential for the learner to enable them to develop their ability to problem solve at a pace that would far outstrip their unassisted efforts (Wood, Bruner & Ross, 1976).

Vygotsky (1986) claimed that the *Zone of Proximal Development* was the place where the learner's concepts, which he stated may be empirically rich, but are

likely to be disorganised and spontaneous, meet the systematicity and logic reasoning of the adult. This *Zone of Proximal Development* is where the challenge of learning resides (Torrance, 2012). It is conceptualised as the difference between the teacher and student, and between the students' present knowledge and future understanding (Torrance, 2012). When discussing the *Zone of Proximal Development,* Torrance (2012) states that the idea of 'closing the gap' (p. 333) is often raised in the literature and questions the efficacy of it as a metaphor in learning. He argues that "not only does the idea of a 'gap' imply a linear model of closure, but it also implies that closure is a good thing, that closure of the gap is what feedback should be trying to achieve" (p.333). The idea of 'gap' implies an incremental, building block, linear model of constructing knowledge (Torrance, 2012) akin to traditional behaviourist approaches to teaching.

This difference in the understanding of the learner is therefore not so much a gap in knowledge, but rather a zone of nonlinear development personalised for each student, and as such it is important educationally (James & Lewis, 2012). Teaching at this point is the "crack where light gets in" (Torrance, 2012, p. 333), as the *Zone of Proximal Development* provides a "*'horizon of possibilities*' to be reached" (James, 2006, p. 57), where growth takes place on many interrelated fronts (Sadler, 1989), thus affording teachers the opportunity to explore and exploit the differences in the understanding of their students through pedagogic action, including feedback, so that students come to understand the issues at stake and what learning means for them (Torrance, 2012). Vygotsky (1986) argued that the progress in concept formation by a child achieved in cooperation with a MKO would be a much more sensitive gauge of the child's intellectual abilities. These understandings about learning and teaching as part of the socio-cultural constructivist theory of learning resonate with the ideas proposed by Driver et al. (1994), Driver et al. (2000), Harrison (2015) and Harlen et al. (2015), with regards to learning in science.

James (2006) contends that one of the most important aspects of the broadening of the constructivist approach, in both theory and practice, has been taking on board the importance of the social dimension of learning with others. Engaging in discussions with peers and the teacher is a fundamental aspect of science learning for sociocultural constructivists. The current conceptualisation of science education is therefore rooted in a sociocultural constructivist view of learning (Heritage, 2010; Scott, 1998; Pellegrino, Chudowsky & Glaser, 2001; Shepard, 2000: Trumbull & Lash, 2013).

However, even though research literature draws upon these two theories as the means by which students construct meaning in science, in many of today's classrooms students engage in learning methods that draw on behaviourist pedagogical approaches. Behaviourist theories of learning such as those of Pavlov's (1927) classical conditioning (an unconditioned reflex response/behaviour, occurring automatically through the association of two specific linked stimuli), and Skinner's (1953) operant conditioning (a behaviour preceding a certain kind of stimulus, including rewards and punishments), are based on the principle of stimulus and response. In such learning environments, the teacher is in control and directs learners, who respond accordingly, resulting in noticeable changes in behaviour (Agarkar & Brock, 2017; Bates, 2016). In behaviourist dominated classrooms, teachers act as though science learning is the accumulation of a body of knowledge, based on the notion that the learning of complex competencies can be broken down into discrete skills learnt separately by developing individual stimulus-response bonds (Buhagiar, 2005). Teaching approaches in science would include "drill-like practice and the transmission of facts and principles" (Agatar & Brock, 2017, p. 94). Such approaches to science teaching clearly align to behaviourist theory, in which learning is seen to be linear and sequential, with complex understandings of science phenomena only occurring by the accumulation of elemental, prerequisite learning.

A behaviourist learning model "precludes students moving to higher levels until the prior level has been mastered, and rests on the idea that repetition is the only way to remedy deficient skills acquisition" (Buhagiar, 2005, p. 46). As such, a criticism of behaviourist approaches to science teaching is that it can be a transmission-led approach to learning which fails to take account of the differences of learners, the enquiring nature of individuals (qualities deemed essential for scientists), and precludes students from engaging in activities which involve them practising higher order skills (Bates, 2016; Buhagiar, 2005). Regulating students' access to opportunities in which they can employ higher order skills has the dual limitation of not allowing them to develop their problem solving or thinking skills, which are essential for science learning if students are to be able to understand phenomena and utilise ideas and concepts across a variety of contexts. It also hinders the potential to develop or strengthen their 'basic skills' in science (Buhagiar, 2005).

There is, however, the potential for behaviourist theory to influence teaching approaches utilised within science classrooms, including how teachers engage with

students and provide feedback. As discussed in section 1.3.2, the reasons for this could be attributed to the current landscape within the UK, including the increased accountability measures and continual pressure for schools and teachers to raise attainment outcomes for their students. All of which have the potential to promote behaviourist approaches in order to ensure students perform and pass exams at the expense of deeper learning in science. However, it is an oversimplification to suggest that teachers' practices act in alignment with a single theoretical approach. Instead it is more likely that they employ a range of practices in which one theoretical approach might dominate (Niederhauser & Stoddart, 2001).

Nevertheless, in spite of the external pressures currently prevalent in education in the UK, it is evident from the review of literature associated with science education that the approaches underpinning effective learning in science consist as a blend of cognitive and sociocultural constructivist theories. This view of science learning draws theoretical vitality from the use of a range of pedagogical practices utilised within science classrooms. A significant constructivist pedagogy associated with both cognitive and sociocultural theories is the use of feedback, which will be discussed in greater detail later in the chapter; how conceptualisations of science teaching practices relate to learning in science is discussed in the following section.

2.4 Teaching and Learning Practices in Science

All of the characteristics of effective learning identified, underpin the features and purposes of science learning needed by today's students, and align with constructivist approaches. Further analysis of the literature related to learning in science identifies aspects of teaching that are of particular importance in promoting student understanding, and are considered in the following sections.

2.4.1 Inquiry-based Science Education Including Practical Work

Traditional approaches to science teaching were perceived as involving teachers delivering science ideas as though they were a series of facts or theories that have been proved to be correct and to be learnt by students, and clearly follow the norms of behaviourist theory. With regards to students actively constructing meaning in science, there is one key approach supported in the last decade by an increasing body of research on its effectiveness, that Harlen et al. (2015) claim is being embraced in principle across the globe, and that is inquiry-based learning. An inquiry-based approach to learning in science involves students asking questions to which they do not know the answer, and subsequently collecting, analysing and

interpreting evidence to develop ideas and explain scientific phenomena in order to make meaning and deepen understanding.

In order to answer these questions, students need to engage in mental and physical activity which will involve them using creative thinking, reasoning and problem solving (Harrison, 2015; Harlen et al., 2015; Leach & Scott, 2003), approaches which align to constructivist theories. This construction of knowledge is achieved through personal and social experiences and in this sense students in science classrooms need to work in ways that are similar to those of modern day scientists (Driver et al., 1994; Harrison, 2015; Harlen et al., 2015). There are a number of different aspects of the science curriculum that do not necessarily need to be learned by drawing on inquiry approaches. However, inquiry is seen as having a key role to play in helping students develop understanding in science (Harlen et al., 2015).

One way in which inquiry-based learning is manifest in classrooms across the globe is by students engaging in practical work, activities in which the students manipulate and observe real objects and materials (Abrahams & Millar, 2008), in order that they develop some appreciation of the nature of scientific activity. By anchoring practical work to situations in which science is used in everyday life, students' interest and engagement can be captured, thereby increasing their ability to make links between phenomena (Osborne, Simon & Collins, 2003; Harlen et al., 2015). Making links in science is a key aspect of learning in the subject, as it helps students develop scientific understanding so they can explain new scientific phenomena. This is a vital aspect of science learning as understanding within this field continues to evolve. Practical work is therefore a key approach utilised in science teaching associated with constructivist theories, as it can support students in building connections and recognising patterns, and increase engagement and interest so that they are enabled to understand scientific principles and consequently be able to apply and use the ideas in new situations. Indeed a recent report by Gatsby (2017) claims that despite the growing power of digital technology to simulate the real world, practical science is as highly valued as ever.

Although many within the science education community see practical work carried out by students as an essential feature of science education Abrahams and Millar (2008) question this assumption. They state that there have been a number of queries raised by science educators regarding the effectiveness of practical work as a pedagogical approach in science learning. Millar (2004) explains that strategies

for improving practical work intended to develop students' scientific knowledge have a common aim – to make the students *think* as well as *act*, i.e. that the practical tasks that are effective are those in which students are not only 'hands on' but also 'minds on'. However, Abrahams and Millar (2008) found from the analysis of observational and interview data of a sample of 'typical' science lessons in English secondary schools, that practical work was generally effective in getting students to do what was intended with physical objects i.e. 'hands on', but much less effective in getting them to use the intended scientific ideas to guide their actions and reflect upon the data they collect, i.e. 'minds on'. So even though practical work has the potential for supporting students' learning in science by helping them actively construct meaning through being engaged in practical work, this may not always be the case. Whether students perceive inquiry-based learning or practical work as being beneficial to their learning, and how so, will be discussed in Chapter 5, in which the perceptions of the students in this study and what helps them learn are analysed.

2.4.2 Identifying Students' Ideas

One aspect of teaching associated with constructivist theories involves being aware of the prior knowledge of a student, as this is seen as a powerful determinant of their capacity to learn new material (James, 2006). This is an essential aspect of science teaching as it is recognised that the initial ideas students hold, formed from their interpretations of scientific phenomena they have experienced in their everyday lives, influence the sense that they make when engaging with ideas in the classroom (Driver et al., 1994; Driver et al., 2000). Many of the ideas that students bring will be in keeping with the science being taught. However, in many cases there are alternative conceptions of phenomena and ideas that are contrary to the scientific view (Driver et al., 1994; Driver et al., 2000).

There is the possibility, therefore, of a range of different starting points existing within any one classroom. Science teachers consequently need to teach science with students' thinking in mind if they are to support them in making sense and constructing appropriate scientific meaning. Driver et al. (2000) advise that in order for science teaching to be better adapted to students' prior schemes (an individual's knowledge about a specific phenomena), teachers should consider carefully: the choice of concepts to teach; the choice of learning experiences; and the presentation of the purposes of the proposed activities in order to demonstrate the reasons why the accepted scientific viewpoints are better. The learning experiences that teachers create should discuss explicitly students' alternative ideas

in order to cognitively challenge and consolidate their learning of science (Agakar & Brock, 2017; Muller, 2012). Driver et al. (2000) argue that students' alternative ideas can be persistent and stable, and that without teaching to challenge them students will fall back on their own perceptions and reasoning of phenomena, which may inhibit their understanding and consequent performance. Leach and Scott (2003) in their critique of constructivist views of learning in science education, argue that there are limitations in portraying science learning in classrooms fundamentally in terms of changes in the 'mental structure' of individuals; however, they proceed to contend that considering students' alternative ideas in science is a useful approach to teaching science.

2.4.3 Classroom Dialogue

Learning is socially constructed (Vygotsky, 1978), and communication through dialogue is essential in achieving this (Harrison, 2015). Dialogue, can take place in any organisational context, be that as whole class, small group or individual discussions. "It commands attention to the power of talk in teaching and learning wherever it is used" (Alexander, 2014, p. 22). Teachers can elicit students' ideas and help them construct meaning in science through the facilitation of dialogue. Not only does this help teachers ascertain evidence of students' thinking, and prior understanding about science concepts, when used with the whole class or small groups it is also one way to support students in collaborating in their learning, one of the key features of constructivist learning theory previously identified. Therefore, in terms of the key aspects of oral practices evident in science classrooms, it is well-managed classroom discussions that employ the targeted and planned use of questions (Harrison, 2015) that open up thinking and challenge students cognitively, along with feedback interactions, which help students to learn (Driver et al., 1994; Harrison, 2015).

Alexander (2014) suggests that teachers should undertake dialogic approaches within the classroom if they are to help students think more deeply and learn more effectively than they do (Harrison, 2015). Mercer (2007) refers to Alexander (2014) as the originator of the term 'dialogic teaching' and proceeds to use the term to distinguish teaching which actively engages students in a coherent and cumulative process of learning from ways of teaching that do not. However, Mortimer and Scott (2003) present an alternative use of the term 'dialogic', which they use in contrast with 'authoritative' for their categorisation of interactions between teachers and students, in particular in science classrooms. Mortimer and Scott (2003) define authoritative dialogue as oral interactions in which the teacher's

purpose is to focus the students' full attention on just one meaning of the science being presented. In contrast, Mortimer and Scott (2003) use the term dialogic to indicate that the teacher aims to recognise and take into account a range of students', and others', ideas. As Mercer (2007) argues, whilst both dialogic terms have similar roots being grounded in classroom dialogue and interests in pedagogic effectiveness, the "two conceptions of 'dialogic', having developed independently, are difficult to reconcile into one analytic scheme" (p. 3). With regards to this study, even though Mortimer and Scott's (2003) definition is associated with science teaching, it is less pertinent and relevant than the concept of dialogic teaching proposed by Alexander (2014). Mercer (2007) discusses how, with dialogic teaching, there will be distinct repertoires and indicators present in classrooms. This is because the definition of dialogic classrooms proposed by Alexander (2014) involves interactive experiences in which the power of talk is harnessed to engage, challenge, stimulate and extend the thinking, and advance the learning and understanding of students, a view that aligns to the definition of learning in science propositioned previously.

Alexander claims that there are five key principles associated with dialogic teaching, which are that such teaching is: "(1) Collective: teachers and students address learning tasks together, whether as a group or a class. (2) Reciprocal: teachers and children listen to each other, share ideas and consider alternative viewpoints. (3) Supportive: students articulate their ideas freely, without fear of embarrassment over 'wrong' answers; and they help each other to reach common understandings. (4) Cumulative: teachers and students build on their own and each other's ideas and chain them into coherent lines of thinking and enquiry. (5) Purposeful; teachers plan and steer classroom talk with specific educational goals in view" (2014, p. 28).

Harrison (2015) claims that the two most important features of Alexander's perception of classroom dialogue for learning in science are that the dialogue is both 'reciprocal' and 'cumulative', so that "individual teacher-student and student-student exchanges are chained into coherent lines of inquiry where connections, relationships and differences help shape the understanding of all those involved" (p. 83). However, if teachers are to draw on sociocultural constructivist pedagogies to build a climate for learning in science in which they plan to teach with students' thinking in mind, then the collective and supportive aspects of Alexander's dialogic classrooms is of equal importance and should be added to the list proposed by Harrison.

Alexander (2014) provides a wide range of characteristics that he claims are indicative of dialogic teaching; this study suggests that these and similar approaches are also prevalent in literature that provides guidance for teachers on approaches that support science teaching. Examples of characteristics and strategies mentioned by both dialogic teaching and literature pertaining to science learning are: the facilitation of questions being asked from students; students being confident to air their thinking and make mistakes and encouraged to do so; questioning that builds on previous knowledge; informative feedback; activities that engage all students in talking and responding in the lesson such as concept cartoons (Alexander, 2014; Wellington & Osborne, 2001).

The use of questions that open up students' thinking is a particularly useful mechanism in establishing a constructivist and dialogic learning environment (Alexander, 2014; Driver et al., 1994; Hardman, Abd-Kadir and Smith, 2008; Harrison, 2015; Torrance & Pryor, 2001), where 'open' implies using authentic questions that are more cognitively demanding for the student, require more than just recall of knowledge or recitation of basic information, and which the teacher has not prespecified or implied a particular answer (Alexander, 2014). Black et al. (2002) discuss how open questions are questions that support students in expressing and discussing their understanding, thus enabling teachers to "explore issues that are critical to the development of students' understanding" (2002, p. 7). Open questions involve: asking the respondent to *think* and reflect; to give *opinions* and *feelings*; they hand control of the conversation to the *respondent*. Conversely, closed questions *'can be answered with either a single word or a short phrase',* with questions where a 'yes' or 'no' answer can be provided as subclass of these*.* Closed questions involve: giving *facts*; they are *easy* to answer; they are *quick* to answer; and they keep control of the conversation with the *questioner* ("Open and Closed Questions," n.d., para. 1).

There are many research references that claim that teachers ask on average between 300-400 questions each day, with the minority of them being open and requiring cognitive interactions from students. The sources for this claim are often cited as being associated with Hattie (2012a). However, exploration of this assertion showed that it has also been linked to Blosser (2000), Brualdi (1998) and Leven and Long (1981). Having investigated further, it appears that the original source underpinning these claims comes from work carried out by Gall (1970), who analysed the use of questions in the classroom over a fifty-year period. Gall (1970) does not in fact cite the oft seen figure of 300-400 questions per day, but rather

discusses a number of studies, in which the average use of teachers' questions ranged from 64 questions in a 30 minute period up to 395 questions per day. Consequently, this repeatedly cited assertion is flawed; however, it does support the notion that teachers use a lot of questions as part of their everyday practices. Gall (1970) claims that there was no essential change in the types of questions that teachers employed in the classroom across the time period. Gall (1970) contended that: about 60% of teachers' questions required students to recall facts; about 20% were open and required students to think; and the remaining 20% were linked to procedural communications. Further exploration was unable to identify how Gall (1970) categorised the questions linked to tasks within the procedural or recall of facts types in her analysis.

Alexander (2014) argues that from the comparative study of classroom practices across international public primary schools, dialogic teaching is an approach that can be utilised efficiently and economically, employing open questions to accelerate and consolidate the learning and progress of students, again highlighting the importance of oral interactions for learners. This, he claims, is attained as dialogic teaching engages students and informs both them and the teacher how learning is progressing, approaches which are affiliated with constructivists' theories of science learning. Therefore, dialogic teaching can operate as a mechanism to effectively interface between science teaching and learning, and one could expect to evidence it in classrooms where high levels of oral feedback are manifest.

Another form of whole-class activity that involves dialogue and has been show by research to benefits students' learning is whole-class interactive teaching (Petty, 2009a, 2009b). During whole-class interactive teaching the teacher is in control; however, all students are expected to be active and engaged, be that by: providing reasoning; making their own sense of the ideas and skills they are learning; or demonstrating skills being learned, all of which should occur in an atmosphere that is both collaborative and supportive (2009b). Petty stresses that interactivity on the part of the learner is the crucial element of such whole-class approaches (2009a, 2009b). Approaches that form a subset of whole-class interactive teaching include: direct instruction; explicit instruction; and active instruction (Petty, 2009a). However, there are no agreed structures for any of these methods, though they have similar characteristics; namely, that they are highly structured, teacher controlled and active for the learner. Petty (2009a) discusses that one aspect of why whole-class interactive teaching works is due to the teacher

showing in a step-by-step way how ‘to do it’ through modelling. Petty (2009a) discusses that modelling can be delineated into three subcategories involving demonstrating: (1) a practical skill – such as how to serve in tennis. (2) An intellectual skill – such as how to carry out a mathematical calculation. (3) A high-order intellectual skill – such as how to analyse imagery in a poem. All of these different skills - practical, intellectual and high-order intellectual - are required by successful learners in science as they grow both their ideas about science phenomena and develop their knowledge, methods and practices about the nature of science. Although it is not the focus of this study to conduct detailed analysis into oral talk patterns, it is acknowledged that talk patterns should be considered when data collected from the teachers are analysed. Of more importance for this study looking at science classrooms, is the utilisation of open questions and the way the teacher interacts with the class, either collectively or as individuals/small groups. Such approaches will be explored in Chapter 6 where science teachers’ classroom practices are examined in detail

2.4.4 Collaboration with Peers

Another of the features of learning identified within constructivist theories was the need for learners to collaborate in order to develop their understanding. Socially constructed dialogue with peers is vital in science classrooms as it supports students to develop their understanding through reflecting upon and changing the ways they interpret reality (Harrison, 2015; Wellington & Osborne, 2001), and also involves them working in ways similar to those of scientists (Harlen et al., 2015).

EEF (2017), in their review of research, define collaborative learning using both the terms collaborative or cooperative learning. They go on to define these approaches to learning as learning tasks or activities in which students work together in a group small enough for everyone to participate on a collective task that has been clearly assigned. An aspect of cooperative approaches identified as a beneficial for students’ learning from research conducted in formal learning settings, is activating them as learning resources for each other (Johnson, Johnson and Stanne, 2000; Johnson, Maruyama, Johnson & Nelson, 1981; Kyndt et al., 2013; Nunnery, Chappell & Arnold, 2013; Nuthall, 2007; Puzio & Colby, 2013). However, analysis of the evidence indicates variations in the effectiveness of such approaches, dependent on the study domain, the age level of the students and the culture in which the study took place (Kyndt et al., 2013). Nevertheless, collaboration amongst students is also a fundamental facet of teaching associated with constructivist theories of learning in science.

With respect to peer feedback there have been claims that it is potentially more influential than teacher feedback in obtaining lasting performance results, with excessive feedback from a teacher having detrimental results and students appreciating the immediacy of the interactions (Howard, 2014; Murdoch-Eaton and Sargeant, 2012). How students are grouped and activated to work as learning resources for each other, and whether they perceive discussing ideas with their peers to be beneficial to their learning, is something that will be addressed in chapters 5 and 6, in which students' perceptions and teachers' classroom practices will be analysed.

Even though science teachers may draw on research evidence to plan and use appropriate teaching approaches to create learning experiences for their students, the learning that occurs may be different across the variety of students they teach. The students may develop different ideas and explanations than those being addressed (Nuthall, 2007), their understanding may go 'backwards' as they unpick their thinking and begin to align it to the scientific view, or it may take time for links to be made that connect ideas and explain phenomena in the minds of the learner (Driscoll, 2011). Nuthall (2007) contends that "learning does not come directly from classroom activities; rather learning comes from the way students experience these activities" (p. 155).

Therefore, learning and learning in science is a complex process with regards to how students develop their ideas and understanding. It is complex because learning is neither linear nor predictable (James & Lewis, 2012; Torrance, 2012), and consequently the extent and nature of individual students' learning is highly varied. Individual students vary for a number of reasons; these include students' background knowledge, interests, motivations, experiences and their prior knowledge, and the ways in which they conceptualise scientific phenomena (Nuthall, 2007; Watkins et al., 2002). In the next section, consideration will be given to the research literature associated specifically with learning, assessment and feedback, as this is the context for the study.

2.5 Interdependence Between Learning, Assessment and Feedback

> *One of the most surprising things about the field of feedback research is how many studies of feedback pay relatively little attention to the nature of learning, and the cognitive processes involved. (Wiliam, 2018, p.12)*

The fluid contextual model of school learning represented by Watkins et al. (2002) (see figure 2.1) highlights the interdependent nature of interactions between the teacher and the students that can occur within the classroom setting as learning occurs. Orsmond, Maw, Park, Gomez and Crook (2011) argue that feedback, along with assessment, are important drivers of what, when and how students learn; and 'good' feedback helps students understand their subject area whilst also providing clear guidance on how to improve their learning. Murtagh (2014) contends that the use of classroom assessment that includes the use of feedback as a means of promoting student learning is strongly supported by current national and international educational research and policy (DfE, 2015). The following section analyses the literature pertaining to learning, assessment and feedback in order to establish what sense can be made form the literature as to the interface of feedback with learning, and therefore how this study can add to thinking in the field.

The etymology of the word 'assessment' derives from the Latin '*assidere*', meaning to 'sit by' - an indication of the synergy between the teacher and the student during teaching and how assessment and feedback can be used to inform the learning process. Teaching and learning do not necessarily need to be interdependent activities. However, in order for the teacher and/or the student to be aware of what progress they have made, and what the implications are for learning, some form of assessment needs to be carried out. Gibbs (1999) contends, "assessment is the most powerful lever teachers have to influence the way students respond to the course and behave as learners" (p. 41). As such, assessment is an integral part of all aspects of school life (Tarras, 2005) and therefore a fundamental feature of a teacher's repertoire, being used daily both consciously and subconsciously as they interact with their students.

Sadler (1989) defined assessment as any appraisal (or judgement, or evaluation) of a student's work or performance in which the assessment process involves the mechanics or steps required to effectuate the judgement (Tarras, 2005). Sadler (1989) cites the etymology of the adjective 'formative', stating that it is associated with forming or moulding something, usually to achieve a desired end. Sadler (1989) goes on to define the term formative assessment as being concerned with "how judgements about the quality of student responses (performances, pieces, or works) can be used to shape and improve the student's competence by short-circuiting the randomness and inefficiency of trial and errors" (p. 120). In a

subsequent article, Sadler (1998) further defines formative assessment as assessment that is specifically intended to provide feedback on performance to improve and accelerate learning. Both of Sadler's (1989, 1998) definitions imply that judgements of the performance level of the student have to occur, and then this information needs to be acted upon to improve the student's learning. However, in contrast to the first definition, the later one uses the term 'feedback' as part of the pedagogical approach taken during formative assessment to accelerate the student's learning.

Formative assessment was a term first employed by Scriven (1967). Scriven describes formative assessment from the perspective of a curriculum builder and highlights some interesting aspects of formative work that can be applied, he claims, to other kinds of evaluation. Scriven (1967) describes how during the process of developing new material, a curriculum evaluator would be field-testing the work whilst it is being developed, so that the new becomes better than the current. This explains how the formative evaluation process involves the individual receiving feedback so that they can undertake subsequent revisions to their work, whilst creating new material. Some initial principles are highlighted here: the involvement of the individual in their own learning; the iterative nature of the process; the function of assessment and feedback within formative practices to improve learning and performance, in this example of the curriculum, and that feedback in Scriven's (1967) description occurs during the learning.

Black and Wiliam (1998a) state that formative assessment is linked with activities utilised to provide evaluative information, and argue that the evidence elicited should be used as feedback, to modify the teaching and learning activities in which students are engaged. Hattie (2003) claims that the primary concern of assessment is with providing teachers and/or students with feedback information (and not about "tests", although tests can be one mechanism to provide feedback information). Therefore, there is another important characteristic of the interface between assessment, learning and feedback: not only does the assessment involve making judgements with the providing of feedback being a central theme, but there is also the need to modify teaching as a consequence. Interestingly, in their subsequent work Black et al. (2002) add to their initial definition of formative assessment that as well as being used by the teachers and the students in assessing themselves, students can also use the information. This indicates that it is not only the teacher who can respond and adapt as a consequence of some assessment and feedback taking place, but that the student can as well.

Tunstall and Gipps (1996) also discuss the interface between assessment, feedback and learning when they define formative assessment as the process of appraising, judging or evaluating students' work or performance and using this to shape and improve their competence. They link this definition of formative assessment to feedback by citing work by Gipps (1994) where they claim in everyday classrooms this would involve teachers using their judgements of children's knowledge or understanding to *feed back* into the teaching process and to determine for individual children whether to re-explain the task/concept, to give further practice on it, or move on the next stage (Gipps, 1994). This definition links to the idea that feedback involves some element of improvement as a consequence of the dialogue that has taken place. This improvement need not necessarily be related to intended learning objectives or observable outcomes, but rather to improved understanding and learning for the student (Torrance, 2012). It also indicates the symbiotic relationship between assessment and feedback for the benefit of promoting learning. However, learning does not always immediately follow feedback, and even if students report potential benefits, learning may occur at some distance from the lessons after data have been collected.

Didau (2015) argues against the importance attached to formative assessment as a concept, claiming that at best it can evidence what a student has not learned, never what they have learned. This, he contends, is because learning cannot be seen; it is performance, he claims, that can be ascertained. This is because performance is an indication of what a learner is able to do, whereas learning occurs by way of students constructing meaning as they formulate new knowledge. Didau (2015) asserts that providing feedback that supports learning is a lot harder to accomplish and predict than imagined, as it involves provoking thinking in the student. Sadler (1998) discusses how the sole criterion for judging the desirability of feedback should not be that it leads to improved learning. He argues that research of it needs to inform, influence and develop a learning culture that makes feedback work for students.

Wiliam (2011) states an important feature of feedback, taken from the engineering context, is that it forms part of a feedback loop, i.e. information is continually being gathered, assessed and fed back. Subsequently this is acted upon to alter what is occurring, and the resulting change in the current level is again assessed and looped back as previously into the system. Wiliam (2011) maintains that unless there is a mechanism within the feedback loop that brings the current state closer to the desired state then the system is useless. Sadler (1989) contends

that feedback is a key element of formative assessment and that few physical, intellectual or social skills can be acquired satisfactorily simply through being told about them. This conceptualisation of assessment and feedback functioning in a formative way affiliates with the constructivist approaches which underpin the effectual learning of science, and conveys the importance of the student being actively involved in the process as they construct meaning. It is by practising in a supportive environment, which incorporates feedback loops, that makes the acquisition of physical, intellectual or social skills successful (Sadler, 1989). The cyclical nature of the process is therefore important, and will be explored further in section 2.6.1 when feedback is defined.

Giving, receiving and acting on information during feedback is cyclical in nature, and aligns with the idea of feedback loops (Askew & Lodge, 2000; Gershon, 2017; Goetz, 2011). Goetz (2011) describes how the concept of feedback loops has its roots in psychology, and was seen as a way of affecting changes in the behaviours and motivation of individuals. Goetz (2011) defines a feedback loop as a means of providing people with information relating to their actions and providing them with the opportunity to change these actions, consequently improving their behaviours, or more succinctly: action; information; reaction. Goetz (2011) describes how completing a feedback loop entails four distinct stages. He describes these as: First stage – the evidence stage, facilitated through the collection of data; i.e. a behaviour must be measured, captured, and stored. Second stage – the relevance stage, involving the relaying of information to the individual, not in the raw-data form in which it was captured, but in a context that makes it emotionally resonant. Third stage – the consequence stage, in which the information provided to the individual must illuminate one or more paths ahead. Fourth stage - the action stage, in which there must be a clear moment when the individual can recalibrate behaviour, make a choice, and act. Subsequently, “that action is measured, and the feedback loop can run once more, with every action stimulating new behaviours that inch us closer to our goals” (Goetz, 2011, para. 9).

Given the idea that feedback loops can be used to change people’s behaviours, this means that they can be utilised to support students in improving their learning and performance, therefore enabling the learner to progress. From the review of the literature, the principles associated with assessments that function formatively and actively engage students in their learning are by nature constructivist, and utilise feedback as a mechanism for promoting learning. Formative practices linking teaching, learning, assessment and feedback involve teachers: (1) starting from

where the learner is. (2) Recognising that students have to be active in the process and reconstructing their ideas (learning has to be done **by** them; it cannot be done **for** them). (3) Sharing learning goals with students. (4) Helping students to know and to recognise the standards they are aiming for and take responsibility for steering their learning in the right direction. (5) Involving students in self-assessment and taking action to move closer to the learning goals, including expressing their ideas and having the opportunity to try out ways in which new inputs might make sense to them, as 'talking the talk' is an important part of learning. (6) Providing feedback that leads to students recognising their next steps and how to take them (Assessment Reform Group (ARG), 1999; Black & Harrison, 2004; Blanchard, 2008, 2009; Brookhart, 2009), as such, learning, assessment and feedback are inextricably linked.

However, the interplay between how these different facets are actualised in the classroom can occur in different ways. Research into feedback has drawn on a range of theoretical perspectives on learning (Thurlings et al., 2013), each of these is based on a different set of assumptions and therefore emphasise different aspects of learning (Agarkar & Brock, 2017). This has implications for how feedback is understood. Behaviourist approaches to learning associate the process with: the acquisition and use of knowledge. Such approaches present a teacher-centred method akin to an input-output model, where students receive and then use information with which they have been provided (ASHE-ERIC, 1986; Bates, 2016; Buhagiar, 2005; Hargreaves, 2016; Watkins, et al., 2002, 2007). Behaviourist approaches involve teaching that is more likely to lead to students adopting superficial approaches to learning such as rote memorisation, where they treat material as different facts and unrelated topics, which in turn can lead to shallow learning (Buhagiar, 2005; Watkins et al., 2002). Within a behaviourist perspective, feedback interactions would involve the teacher providing their students with the information they need, in order to know what needs to be done, how it needs to be done, and what evidence of change needs to be produced.

Whereas, constructivist approaches to learning suggest the process is: a meaning making activity undertaken by students which is affected by a wide number of different factors, such as students' background knowledge, interests, motivations, emotions and experiences. Proponents of constructivist approaches to learning stress that the students try to make sense and construct meaning through making connections between new information and experiences and the prior knowledge they already posses (ASHE-ERIC, 1986; Bates, 2016; Hargreaves, 2016; Nuthall,

2007; Schwartz, 1980, Voerman et al., 2014; Watkins et al., 2002, 2007). Constructivist approaches to learning therefore advocate a more dynamic approach to teaching. This involves an active undertaking by the student as they search for meaning, underlying principles, structures that link different concepts or ideas together, along with widely applicable techniques, which in turn have the potential to lead to more effective and deeper learning (Askew & Lodge, 2000; Buhagiar, 2005; Watkins et al., 2007). Within a constructivist perspective, feedback interactions would involve the teacher working with their students to help them identify what needs to be done, how it needs to be done, and what evidence of change needs to be produced. The following section will examine one such model that has cogency with this study, and will be drawn on in later chapters when analysing teachers' classroom practice.

2.5.1 Ideal Typical Approaches to Learning and Assessment

Torrance and Pryor (2001) conducted a collaborative action research project in primary schools between university-based and teacher researchers. The study examined the ways in which routine classroom assessment might be integrated with pedagogy, to maximise its formative potential in promoting learning. From the analysis of the classroom observations they proposed a model of "classroom assessment as an '*intersubjective'* social process situated in, and accomplished by, interaction between students and teacher" (p. 616). They identified two 'ideal-typical' approaches to formative assessment that nevertheless were not necessarily mutually exclusive in practice: one *'convergent'*, the other *'divergent'* (see Table 2.2).

Convergent	Divergent
Assessment which aims to discover ***if*** the learner knows, understands or can do a predetermined thing. This is characterised by: **Practical Implications** a. Precise planning and an intention to stick to it; b. Tick lists and can-do statements; c. An analysis of the interaction of the learner and the curriculum from the point of view of the curriculum; d. Closed or pseudo-open teacher questioning and tasks; e. A focus on contrasting errors with correct responses; f. Judgmental or quantitative evaluation; g. Involvement of the student as recipient of assessments . **Theoretical Implications** h. A behaviourist view of formative assessment focused on communicating criteria usually closely related to those used in summative assessment; i. An intention to teach or assess the next predetermined thing in a linear progression. j. A view of assessment as accomplished mainly by the teacher. This view of assessment might be seen less as formative assessment, rather as repeated summative assessment or continuous assessment.	Assessment which aims to discover ***what*** the learner knows, understands or can do. This is characterised by: **Practical Implications** a. Flexible planning or complex planning which incorporates alternatives; b. Open forms of recording (narrative, quotations etc.); c. An analysis of the learner and the curriculum from the point of view of both the learner and of the curriculum; d. Open questioning and tasks; e. A focus on miscues – aspects of learners' work which yield insights into their current understanding – and on prompting metacognition; f. Descriptive rather than purely judgemental evaluation; g. Involvement of the student as initiators of assessments as well as recipients; **Theoretical Implications** h. A social constructivist view of education; i. An intention to teach in the zone of proximal development; j. A view of assessment as accomplished jointly by the teacher and student. This view of assessment could be said to attend more closely to contemporary theories of learning and accept the complexity of formative assessment

Table 2.2 Convergent and divergent assessment Torrance and Pryor (2001)

Torrance and Pryor (2001) argued that the two types of practice were associated with how teachers conceptualised learning along with their views on the "relationship of assessment to the process of intervening to support learning" (p. 616). Torrance and Pryor (2001) claim the aim of convergent assessment is to find out ***if*** the learner knows, understands, or can do a predetermined thing; in a sense summative assessment, involving judgements/measurements about past or current performance of the curriculum. Convergent practices, they maintain, are concerned with the teacher's agenda; that is, assessment is the sole reserve of the teacher to inform them of where students are in the coverage of the curriculum, and as such are affiliated with a behaviourist view of learning. Convergent assessment therefore is ***of*** the student ***by*** the teacher to ascertain ***mastery of*** the learning. They also state that convergent assessment is characterised by detailed planning, and accomplished by using closed or pseudo-open questioning and tasks. Convergent approaches would involve the teacher continuing with their course of action and covering the content of the lesson as planned, and being less responsive to cues

given by the students during the learning, and are therefore associated with behaviourist theories.

Convergent and behaviourist approaches to feedback practices would therefore involve the teacher using interactions and assessment evidence to ascertaining the quality standards achieved in students' work. The teacher would then identify errors/mistakes related to the task and provide information or specific praise about the level of competence of the work; this may include rewarding or punishing the student. The teacher would subsequently set improvement targets that could involve the student practising getting something right in order for them to achieve the desired outcome.

Conversely, Torrance and Pryor (2001) assert that divergent assessment is concerned with discovering ***what*** the learner knows, understands, and can do; in a sense formative assessment, informing the teacher of where the students' understanding lies. Divergent assessment allows teachers to respond and teach students in the zone of proximal development (Vygotsky, 1986) in order to maximise learning, and thus is associated with constructivist theories. Divergent practices, they maintain, are accomplished as a joint enterprise between the teacher and the student. Divergent assessment, therefore, consists of the students' ***understanding*** being accomplished ***jointly*** between the teacher and the student to ascertain from ***where*** to teach students to ***improve*** their learning. Torrance and Pryor (2001) argue that divergent practices would be characterised by less detailed planning, and the relevant use of open questions and tasks. Teachers utilising divergent approaches would be considering student responses and what they indicate in terms of their perceptions and understanding, and subsequently responding and adapting teaching if needed during the learning.

Divergent and constructivist approaches to feedback practices would therefore involve the teacher in utilising interactions and assessment evidence to elicit the level of a student's understanding with regards to the learning goal being addressed. The teacher would then work with the student to explore and reflect on the learning and give them responsibility for improving their understanding by providing suggestions or asking questions so that the student makes choices on what they will do next.

Torrance and Pryor (2001) refer to discrepancies between teachers' views and their practices. For example, they suggest that teachers can employ assessment continuously within their learning environment whilst thinking that they

are using it formatively. Nonetheless, there is the possibility of the assessments being used in a sustained manner that is summative in nature; that is, the teacher elicits evidence without actually either responding to it, or using it to impact on their thinking or practice. The different approaches being adopted by teachers utilising formative practices such as assessment and feedback, appear to be associated with their differing beliefs of learning (Agarkar & Brock, 2017; Black & Wiliam, 1998a; Gipps, McCallum & Hargreaves, 2000; Hargreaves, McCallum, & Gipps, 2000; Lee, 2009; Torrance and Pryor, 2001). This indicates a potential incongruity between how teachers conceptualise learning and implement associated pedagogical approaches within their classrooms. These differences may be associated with underlying behaviourist or constructivist perspectives of learning, and how teachers perceive their roles within the classroom. Whether similar discrepancies occur with the conceptualisation and use of feedback by teachers is an aspect of classroom practice that will be examined by this study.

The next section will examine in greater depth the literature related to feedback and its purpose in order to provide clarity as to how it has been interpreted in the study. Various feedback dimensions referenced by literature as supporting student learning will be considered, along with the roles and perceptions of teachers and students.

2.6 Feedback

> *Feedback is a relational, deliberative, communicative process that requires action by both student and teacher in order to understand the disparity between a student's present and developing understanding, who controls it and why, and in which conditions and contexts it exists. (Dann, 2018, p. 141)*

In the next section, a theoretical definition of feedback and various characteristics suggested from research associated with its effective utilisation will be considered to build understanding of how feedback will be interpreted throughout this study.

Although feedback as a pedagogical tool has been cited by several mega-analyses (Black & Wiliam, 1998b; Hattie & Timperley, 2007; Hattie, 2014; Higgins et al., 2011; Kluger & DeNisi, 1996; Shute, 2007, 2008) as having a positive impact on

learner outcomes, this is not always the case. The impact of feedback has been shown under certain circumstances e.g. when related to the individual, 'self' (Dweck, 2000; Hattie and Timperley, 2007; Kluger & DeNisi, 1996) to have a detrimental effect on learner outcomes, so it is important that teachers, those who support them and policy makers are aware of the different approaches that can be adopted when using feedback and consequences that may arise.

Feedback is a term that is regularly used as part of everyday parlance encompassing a myriad of different connotations. Some of the ways that feedback is employed affiliates with interactions, such as those that occur within classrooms, between individuals or indeed within one's self. However, more commonly in schools, feedback has come to be associated with, and disproportionally valued, as a means of providing written comments on students' work (DfE, 2016a; Elliott et al., 2016). Other ways of utilising the term relate to the modification or control of a process or system, as well as describing the distortion of sound that can occur with electrical equipment. For this study it is the first meaning of feedback that will be of interest. Nevertheless, even within the confines of classrooms in which interactions are occurring there are different interpretations of the meaning of the word in common everyday use, resulting in translation issues, which in turn lead to confusion and a lack of clarity. In this sense, feedback is a term that has translation issues similar to the everyday use of the word 'electricity'. Electricity is a term used regularly in conversations to cover a multitude of different meanings. Nonetheless, those with a conceptual understanding of the subject know that electricity, although an oft used term, has actually no meaning at all, and is used as a loose idiom to encompass a wide variety of different ideas; for example people use it when they are discussing electrical charge, electrical current, potential difference, etc. With regards to feedback, even Hattie, whose decades of research identified that feedback was amongst the most powerful influences on achievement, confesses that he has "struggled to understand the concept" (2008, p. 173).

Within educational circles, there are multiple dimensions associated with the term feedback. These relate to the purpose of the interaction, its form (oral or written), conditions, models and foci. According to the research literature, all of these different facets can influence the effectiveness of an interaction, which in turn provides contradictory messages as to what is effective in terms of feedback. It is therefore of no surprise that just like the use of the term 'electricity', the phrase 'feedback' can cause confusion due to the broad gamut of actions and strategies it is employed to describe, and the contradictory findings proffered by the literature.

These different dimensions will be explored in later sections of this chapter, and arguments given that some of these terms actually apply to interactions that are not feedback.

The first aim therefore of the synthesis of literature associated with feedback is to define for this inquiry how feedback is conceptualised, and this will include highlighting what it is not, in order to provide clarity and consistency throughout the remainder of the study when the term ‘feedback’ is being used, and types and actions associated with its use examined.

2.6.1 Feedback Definition

There is no one clear definition or widely accepted meaning for feedback and its associated practices that exists within the research literature. Therefore, in order to add to understanding in the field, a cross-sectional analysis is conducted which will provide a conceptualisation for feedback that will be followed throughout the remainder of this study.

The etymology of the word feedback originates in the early twentieth century and is derived from its use in electronics where it is used to describe the process of returning part of the output of an electronic circuit, device or mechanical system to its input, and as such modifying its characteristics. An oft-quoted example to exemplify the electronics definition feedback is the controlling of the temperature in a room. The analogy describes how this is achieved by the use of a heating/cooling system that uses a thermostat to monitor and adjust its output; the continual looping of information about the temperature of the room is fed back until the desired temperature is achieved (Wiliam, 2011). When the effect of the feedback is to reduce the gap between the actual level of the output signal and some defined reference level, it was called negative feedback. When the converse occurred and the gap was increased, this was referred to as positive feedback (Black & Wiliam, 1998b; “feedback”; n.d.).

This is a broad view of feedback that exists in current thinking, where feedback is seen as a process involving ‘something’ (information, chemical, biological, electrical) received as a consequence of a system monitoring its own output that can be used, or cause changes within, a cycle, gap or system (Costa & Garmston, 2017; Dann, 2018). However, in order to offer intelligibility and insights into the utilisation of feedback within the classrooms of teachers involved in this study, a more nuanced conceptualisation of feedback will now be constructed from the literature.

Kulhavy (1977) defined feedback as “any of the numerous procedures that are used to tell a learner if an instructional response is right or wrong” (p. 211). Ramaprasad (1983) extended the definition and classified feedback as “information about the gap between the actual level and the reference level of a system parameter which is used to alter the gap in some way” (p. 4). Ramaprasad (1983) states that if the information on the gap is merely stored without being utilised to alter the gap, it is not feedback. Sadler (1989) reinforced Ramaprasad’s conceptualisation and also argued that in many educational and training contexts, students produce work that cannot be assessed simply as correct or incorrect. Sadler (1989) also argued that Kulhavy’s traditional definition of feedback is too narrow to be of much use. Rather, a range of conditions and activities need to be undertaken in order for the action to be classed as feedback.

Kluger and DeNisi (1996) conducted an analysis of every study that had been undertaken on the effects of feedback interventions from 1905 to 1995. They discussed how this field of research has evolved from the original focus of knowledge of results interventions, to feedback interventions, which they contend include knowledge of results interventions which is defined by Kluger and DeNisi (1996) as that which provides information about the effectiveness of one’s performance. They claim feedback interventions are broader in scope than knowledge of results interventions, and define feedback interventions as actions taken by an external agent(s) to provide information regarding some aspect(s) of one’s task performance. As such, they expand the definition of feedback interventions, contending they provide more information than just the effectiveness of one’s performance and also include input from an external source. However, the definition they proffer excludes the possibility of feedback being self-generated by a learner.

Many authors emphasise the importance of a learning goal for the individual who is engaging with feedback (Brookhart, 2012, Chappuis, 2012; EEF, 2017; Hattie & Timperley, 2007; Hattie, 2012b; Hattie & Gan, 2017; Wiggins, 1997, 2012, 2106; Wood, Bruner & Ross, 1976). Wiggins (1997) defines feedback as value-neutral, concurring with the idea that it is not about assessing correctness, providing praise, blame, approval or disapproval; this, he asserts, is what evaluation is. Feedback, however, he argues, describes what a learner did or did not do in terms of their goal. Gipps et al. (2000) associate feedback with the teacher providing information regarding a judgement of a student, their strategies and skills or attainment, which they state may often be related to learning goals. Hattie and

Timperley argue that goals without clarity “are often too vague to serve the purpose of enhancing learning” (2007, p. 88). They contest that ‘*success criteria*’ are required, as a means of providing both teachers and students with information, of when and how they have been successful, in relation to critical dimensions of the learning goal. In academic settings clarity with respect to success criteria and learning goals can be defined utilising specific targets, criteria, standards and other external reference points such as exemplars and linguistic and non-linguistic representations. These teaching approaches can be employed to scaffold learning and provide students with information about their present state of understanding (and performance) with respect to these (Black & Wiliam, 1998b; Nicol & Macfarlane-Dick, 2006; Sadler, 1989; Marzano, 2001; Wood, Bruner & Ross, 1976). There are additional benefits for students in using exemplars and linguistic and non-linguistic representations as they afford a means of externalising a reference value and providing concrete representations for students to build meaning (Nicol & Macfarlane-Dick, 2006; Sadler, 1989; Marzano, 2001). This is of particular importance in science as a subject in which many ideas and concepts discussed are abstract, and incorporating such teaching approaches into the lessons allows students to build mental models from such visuals in order to support their burgeoning ideas. Along with feedback being associated with information given to the learner and/or the teacher about the learner’s performance relative to learning goals, EEF (2017) indicate it can take a range of different forms. They state these forms can include written feedback, verbal feedback and peer feedback, indicating that such feedback interactions have the potential to align to cognitive and socio constructivist approaches to learning.

These notions about feedback move away from the idea of it being associated with using information linked to data, and more towards a conceptualisation of utilising it with information connected to specific goals related to learning. However, Askew and Lodge (2000) argue that the dialogue that occurs to support learning as part of feedback is influenced by the teachers’ view of learning and consequently how they utilise learning goals. They also contend that the use of feedback can be broadened out not only to be information provided by a teacher, but could also involve the students in constructing their own information depending on the prevalence of the underpinning learning theories. As such they propose three models linked to the teachers’ views, where feedback is seen as: a gift; ping-pong; loops. Therefore, in addition to this specific guidance related to the learning of the individual, a further way of improving the usefulness of the feedback for the student

is to include them in selecting and negotiating goals relevant to them (Butler & Winne, 1995; Hargreaves, 2011; Pryor & Crossouard, 2008). Within in a behaviourist classroom, learning goals are likely to be convergent, pre-determined and articulated by the teacher and progress towards them evaluated by them. Alternatively, in constructivist classrooms learning goals will be divergent and established between the teacher and their students, or indeed be constructed internally by the students themselves, and feedback discourse will be utilised to enable students to build understanding, make sense and connections about phenomena or indeed to develop an appreciation of the learning process (see Table 2.3, Askew and Lodge, 2000). This further develops the definition of feedback, and expands it to include: information provided by an agent which supports learning connected to the effectiveness of one's performance and related to learning goals, where learning goals may or may not be generated by the learner.

Feedback Analogy	Model of Teaching	Role of Teacher and Goals of Teaching	View of Learning	Feedback Discourse	Relevant Learning Theory
A Gift	Receptive-transmission	• Expert • To impart new knowledge, concepts and skills. • Students as passive recipients.	• Cognitive dimensions stressed. • Learning is individual and affected by ability that is seen as fixed. • Learning involves increased understanding of new ideas, memorising new facts, practising new skills and making decisions based on new information.	• Traditional discourse in which 'expert' gives information to others to help them improve. • Primary goal to evaluate. • Feedback is a gift.	Behaviourism
Ping-pong	Constructive	• Expert • To facilitate discovery of new knowledge, concepts, skills. • To help make connections, discover meaning and gain new insights. • Students participate, teacher still in control.	• Cognitive dimensions stressed, although social dimension recognised to some extent. • Learning affected by ability that can develop and is affected by experiences. • Learning involves making connections between new and old experiences, integrating new knowledge and extending established schema.	• Expanded discourse in which 'expert' enables other to gain new understandings, make sense of experiences and make connections by the use of open questions and shared insight. • Primary goal to describe and discuss. • Feedback is a two-way process – ping-pong.	Constructivism
Loops	Co-constructive	• More equal power dynamic • Teacher is viewed and views himself or herself as a learner. • To facilitate discovery of new knowledge, concepts and skills. • To help make connections, discover meaning and gain new insights. • To practise self-reflection and facilitate a reflexive process in others about learning through collaborative dialogue.	• The cognitive, emotional and social dimensions of learning are seen as equally important. • The view of learning is extended to include reflection on the learning process itself and meta-learning.	• Expanded discourse involving a reciprocal process of talking about learning. • Primary goal to illuminate learning for all. • Feedback is a dialogue, formed by loops connecting the participants.	Constructivism

Table 2.3 Models of teaching, learning and feedback (Askew & Lodge, 2000)

Black et al. (2002) state that it is the nature and not the amount of feedback that is critical for improving students' learning. They argue that not only should feedback provide useful information to the learner in identifying what has, or has not, been done well as part of the learning process linked to learning goals, but that it should also provide guidance on how to make any necessary improvements to enhance students' learning further. This they contend would involve a resultant action being undertaken by students using feedback to guide further work. The central point they argue is that feedback should cause the student to think. This has implications for the tasks in which students are engaged, as they would be required to reveal students' understandings and misunderstandings rather than conveying information, a view of teaching and learning which aligns to the divergent and constructivist approach of teaching students in the *Zone of Proximal Development,* and supporting them to take action to develop their understanding. Therefore, added to the definition of feedback being constructed is that of the importance of empowering students to be active agents responding in order to improve learning as part of feedback.

Hattie and Timperley (2007), from their detailed synthesis of meta-analyses, conclude that feedback that is effective in promoting student learning can be conceptualised as information that is provided by an agent, such as: teacher, peer, book, parent, self or personal experience, regarding aspects of one's performance or understanding as a consequence of performance. Interestingly, they go on to describe how the information provided could convey: corrective intelligence; an alternative strategy; clarification of ideas; encouragement or evaluation of the correctness of a response. This conceptualisation of feedback therefore encompasses both behaviourist and constructivist theories. This is because the feedback information provided by the agent in Hattie and Timperley's (2007) definition could be related to evaluations regarding the degree of correctness of the performance as well as the level of understanding of the learner. What is less evident from Hattie and Timperley's (2007) definition is whether the feedback is unidirectional, from the agent to the learner (including themselves), or reciprocal and requiring them to engage in some consequential action to improve their learning or performance. Shute (2007, 2008) concurs that feedback should be non-evaluative, and her definition of feedback aligns with that of Hattie and Timperley (2006) in the sense that she states that feedback is information communicated to the learner.

Hattie and Timperley (2007) therefore broaden out thinking regarding the sources of information available during feedback to the learner; however, there are limitations with their definition in terms of the role feedback has in affecting future learning or performance. Snook, O'Neill, Clark, O'Neill, and Openshaw (2009) suggest limitations associated with the analysis conducted by Hattie and Timperley (2007) as the studies examined are discrete entities aligned to the contexts in which they were undertaken and as such findings may not be replicable or relevant to teachers in other situations. Indeed, Snook et al. (2009) attest that Hattie intended the research to be used as a source for "hypotheses for intelligent problem solving"(p. 104) rather than in a simplistic way.

In addition to the definition provided by Hattie and Timperley (2007), Shute (2007, 2008) contends that feedback is only feedback if it is utilised for the purpose of improving learning, not just providing information regarding aspects of performance or understanding as it is intended to modify the learner's thinking or behaviour. Voerman et al. (2014) also include modifying the learner's motivation within their definition. Therefore, in terms of the conceptualisation of feedback constructed by this study, it is the notion that the source of feedback information can be derived from multiple agents (EEF 2017; Hattie & Timperley, 2007; Shute, 2007, 2008, Voerman et al., 2014) for the purpose of improving learning (Shute, 2007, 2008; Voerman et al., 2014) that holds particular cogency and aligns closer to the view of feedback as an integral aspect of the constructivist view of learning in science.

Providing a judgement and saying what is wrong is not enough, and to be effective, feedback needs to be accurately aligned with where students are at in their learning and must provide a specific recipe for future action to improve learning/performance (Shute, 2007, 2008; Wiliam, 2011). Therefore, just telling the students that their current performance falls short of where they need to be is not feedback. Feedback should provide learners with information about how they are doing in their efforts to reach a goal, and requires that they take action to achieve the goal and receive goal-related information about his or her actions (Shute, 2007, 2008; Wiggins, 2012, 2016; Wiliam, 2011). Feedback functions formatively only if the learner, in improving performance, uses the information fed back to them, and feedback that is not acted upon is defined as summatively functioning (Shute 2007, 2008; Wiliam, 2011). Summatively functioning feedback therefore might be classed as data gathering. The notion of summative feedback aligns with the traditional behaviourist approaches to teaching and learning and convergent feedback, whilst

the idea of formative feedback is associated with more constructivist divergent teaching, learning and feedback approaches. As the conceptualisation of feedback constructed by this analysis has conveyed the idea that feedback requires the learner to take action to improve their learning, then the term formative is tautological.

As a consequence of the cross-sectional analysis of the literature, the theoretical conceptualisation of feedback associated with cognitive-constructive and socio-constructive approaches to learning pertinent to science that will be utilised in the remainder of this study defines feedback as:

> ***Useful information provided from an agent (teacher, peer, book, parent, self or personal experience) which supports learning, relates to learning goals, regarding aspects of one's performance or understanding, and is utilised to improve one's learning of science.***

This is a theoretically fashioned definition of feedback drawing on a variety of different perspectives. It is not the aim of this study to establish the actuality and efficacy of this definition; rather, the aim is to compare this definition to how teachers conceptualise feedback, to identify similarities and differences and use this to inform the design of an observation schedule to study teachers' classroom practices. Alongside the comparisons of teachers' conceptualisation of feedback, an analysis will be undertaken to explore oral feedback interactions related to learning goals that are perceived by students within science classrooms to help their learning. Teachers' classroom practice will be investigated alongside their own and their students' perceptions to deepen understanding regarding aspects of oral feedback practices and behaviours that will be of benefit for teachers, students and policy makers.

The importance of feedback as an integral aspect of learning and assessment has been discussed, and a theoretical conceptualisation encompassing a number of different characteristics has been derived for this study. The subsequent section will examine the purpose of feedback and different approaches to utilising it that have been reported throughout the literature.

2.6.2 Purpose of Feedback

> *People can't learn without feedback. It's not teaching that causes learning. Attempts by the learner to perform cause learning, dependent upon the quality of the feedback and opportunities to use it. (Wiggins, 1997, p. 40)*

The main purpose of feedback is to enhance students' learning (Black & Wiliam, 1998b; Brookhart, 2012; Carnell, 2000; Chappuis, 2012; Dann, 2018; Hattie & Timperley, 2007; Kluger & DeNisi, 1996; Shute, 2007, 2008; Voermann et el., 2012, 2014; Wiggins; 2012, 2016; Wiliam 2017). If feedback can be obtained from a range of agents, including one's self, then feedback is noted as a significant way in which an individual learns and integral to the learning process (Gipps et al., 2000; Hargreaves, 2012, 2014; Hattie & Timperley, 2007; Kluger & DeNisi, 1996; Lucas, 2017; Shute, 2007, 2008; Voermann et el., 2012, 2014; Wiggins, 1997, 2012, 2016). However, as argued earlier, students' learning need not be a linear progression; in fact, in science, as students' ideas and everyday thinking is challenged, deconstructed and then reconstructed, it is highly likely that students will find understanding and learning about some ideas (such as heavy and light objects falling at the same rate) confusing and feel as if their understanding has to take backwards steps before they can explain and construct meaning about phenomena.

Even though feedback is an important aspect in improving learning, the effective utilisation of it is hard to achieve, and is dependent on many interacting factors. As a consequence, feedback is highly situational, and dependent on the social context in which it is interpreted, meaning that the same feedback provided to two different learners could have opposite effects (Dann, 2018; Gamlem & Smith, 2013; Stobart, 2012). As will be discussed, the story on feedback and how it affects learning is not as simple as stating that just because feedback has occurred learning will subsequently take place. In fact, different types of feedback, and the way they are given, have been shown to be differentially effective for learning (Hattie & Timperley, 2007; Kluger & DeNisi, 1996; Shute, 2007, 2008). As Shute (2007, 2008) notes, improvements in learning are dependent on feedback being "delivered correctly" (p. 2), and it is the aim of the following sections of this analysis to identify the key facets associated with feedback that are acknowledged as potentially being more effective in enhancing learning.

Within educational circles researchers argue that there are two overarching intentions attributed to the purpose of utilising feedback to improving learning. These two different intentions link to both behaviourist and constructivist learning theories. Interestingly there are many (Andrade & Cizek, 2010; Dann, 2018; Kerssen-Griep & Terry, 2016; Shute, 2007, 2008) who cite work by Black and Wiliam (1998b) as the source of these two distinct intentions of feedback referred to as:

- *Directive* (in which students are told what needs to be fixed or revised), an approach that aligns to behaviourist theories; and
- *Facilitative* (in which comments and suggestions are provided to help guide students in their own revision and conceptualisation), an approach affiliated with constructivist theories.

However, deeper analysis of the original text and communication with the author (D. Wiliam, personal communication, December 2, 2017) indicates that this is misattributed information, and not categories that they set forth. For this study therefore the ideal typical convergent and divergent approaches to feedback propositioned by Torrance and Pryor (2001) will be used as the framework for considering the two different intentions of feedback. Analysis of the literature highlights how a variety of different ways of categorising feedback has been attributed to these overarching intentions over time. Some of these different categories are proposed as a continuum, or have definitions which mean they could be attributed to either of the ideal typical approaches. However, from the analysis of the literature, each category has been ascribed to the more relevant of the two ideal typical approaches suggested by Torrance and Pryor (2001). A chronological summary of these different categories can be seen in Table 2.4.

Convergent	Divergent
Verification feedback "Dichotomous judgement that the initial response was right or wrong" (Kulhavy & Stock, 1989, p. 285).	*Elaboration* feedback "Substantive information contained in the feedback message" (Kulhavy & Stock, 1989, p. 285).
Evaluative feedback "Judgemental with implicit/explicit use of norms, positive or negative*"* (Gipps, et al., 2000, p. 92; Tunstall & Gipps, 1996; Tunstall Gipps & Harlen, 1996).	*Descriptive* feedback "Specific reference to the student's actual achievement or competence and could relate to either achievement or improvement" (Gipps, et al., 2000, p. 92; Tunstall & Gipps, 1996, Tunstall Gipps & Harlen, 1996).
Directive feedback "Tells the student what needs to be fixed or revised" (Shute 2007, 2008, p. 6).	*Facilitative* feedback "Comments and suggestions help guide students in their own revision and conceptualisation" (Shute 2007, 2008, p. 6).
	Provocative feedback "Prompting further engagement rather than correcting mistakes. Errors treated as miscues, valued for insights they gave into how learners were thinking instead of being dismissed" (Hargreaves, 2011, 2017; Pryor & Crossouard, 2008, p. 4).
Non-autonomy promoting feedback "Intended to promote the student's continuation or cessation of a particular activity, correct answer, feelings of shame or pride, certainty about correctness, increased understanding, grasp of the correct answer, action" (Hargreaves, 2017, p. 88).	*Autonomy promoting* feedback "Teaches the student's singularity, proactivity in learning, metasocial critical inquiry, critical inquiry" (Hargreaves, 2017,p. 87-88).

Table 2.4 Convergent and divergent analysis of feedback intentions

From the analysis, there are a variety of different categories that exist in the literature attributed to the overarching intentions associated with the convergent and divergent approaches of how feedback can be used to improve learning. From the literature review, the categories of feedback claimed to be more effective for learning are associated with the divergent, constructivist approaches to teaching (Gipps, et al., 2000; Hargreaves, 2011, 2017; Kulhavy & Stock, 1989; Shute 2007, 2008; Tunstall & Gipps, 1996, Tunstall, Gipps & Harlen, 1996). The two ideal typical approaches to feedback could involve interactions where teachers provide useful information and discuss goals with the students, which would be conceptualised as feedback by this study. However, this analysis indicates there may be different intentions for how feedback can be used affiliated with different learning theories.

Therefore, what is of interest to this study is how teachers' intentions for using feedback relate to the goals of what they are hoping students improve, be that aspects of performance, attainment or learning. Another facet highlighted are the differing roles undertaken by both teachers and students within feedback, and whether or not students are recipients of information or co-agents in the learning process. As such, these different intentions for using feedback provide some indication from literature of what may be effective and provide a backdrop for the detailed analysis of what occurs within the classrooms of the teachers taking part in this study, in order to provide insight as to oral feedbacks perceived to promote learning in science.

The following section brings together ideas regarding the conceptualisation of feedback constructed by this study, affiliated to the purposes of feedback in promoting learning. This is in order to identify characteristics of oral interactions that will be classed as feedback, as well as those that will not. This examination will be conducted in order to bring clarity with regards to the theoretical conceptualisation and subsequent utilisation of feedback within the classrooms of the teachers involved in this study and the students interviewed.

2.6.3 What Is and Is Not Feedback In This Study

Feedback has been conceptualised in this study as:

> ***Useful information provided from an agent (teacher, peer, book, parent, self or personal experience) which supports learning, relates to learning goals, regarding aspects of one's performance or understanding, and is utilised to improve one's learning of science.***

The conceptualisation of feedback theorised in this study highlights important distinctions between feedback and a number of interactions that can occur amongst teachers and students, including making judgements/evaluations, data gathering, providing advice/instruction and praise.

An evaluation as opposed to feedback, would involve some value judgement about an individual, their learning or performance, and would provide little or no actionable information about what occurred or how to improve (Wiggins, 2012). Feedback therefore which helps a learner improve needs to include information and

detail on which they can act. Consequently, “the use of grades alone or ‘*good 7/10’* marking” (Gipps et al., 2000, p. 7) cannot achieve the purpose of feedback and therefore cannot be classed as such. Wiggins contends that the most ubiquitous form of evaluation is grading, and due to it being so integrated into the school landscape we can easily overlook its utter uselessness as actionable feedback (2012, 2016).

Wiggins argues that advice differs from feedback in that it provides an opinion of what to do, which he asserts “is what many people erroneously think feedback is” (2012, p. 12; 2016, p. 26), whereas feedback, he contests, would discuss what the learner has or has not done in their efforts to attain a learning goal and provide them with useful information related to how they are doing in relation to the goal, from which they can decide what action to take. However, it is contested that unlike an evaluative judgement that provides no indication of what has or has not been achieved, there is the possibility that students may find aspects of information provided as advice which links to learning goals beneficial to their learning. This may occur if the interaction offers ideas of how to improve. Therefore, contrary to Wiggins’ claims, advice may act as feedback for the learner, depending on their understanding of the learning goal and how they are doing in relation to it. Consequently, the most important prerequisite needed for feedback to occur is that learners need to have clarity regarding the learning goals, so that they have a purpose for using the feedback (Brookhart, 2012; Chappuis, 2012; Hattie, 2012b; Wiggins, 2012, 2016).

One type of communication that has been the subject of debate in the literature is the use of praise. Some in the field argue it is more important for students to receive feedback regarding their academic process and classroom conduct than it is to receive the more intensive and evaluative reactions implied by praise (Hattie & Timperley, 2007; Kohn, 1999). There is no strict necessity for students to be provided with praise in order to master the curriculum; indeed, communications such as praise that cue individuals focus on the self rather than on learning appear to be ineffective (Hattie & Timperley, 2007; Kluger & DeNisi, 1996). However, praise is a form of communication that is used regularly by teachers. Zahorik (1968) described how, from the analysis of transcripts of elementary school teachers, teacher-verbal feedback that occurred within lessons was in the main associated with generic praise or approval. However, praise may be counterproductive and have negative effects on students’ self-evaluations of their ability, and the most effective teachers actually praise less than average (Black &

Wiliam, 1998b; Dweck, 2000; Gamlem & Smith, 2013; Hattie & Timperley, 2007; Hymer, 2017; Kohn, 1999). The extent that praise can have a positive effect may well be because of the information it provides regarding one's success at performing a task, and directs praise away from the self. As such feedback would discuss the current level of learning or performance rather than an expression of approval, which may in turn raise motivation, effort and then performance (Gamlem & Smith, 2013; Hattie & Timperley, 2007; Kohn, 1999). Therefore, praise as a communication, is not conceptualised as feedback in this study.

The Australian Society for Evidence Based Teaching (n.d.) exemplify the difference between oral interactions that are classed as feedback and those that are not, using the following examples:

> *'Chloe, your paragraph isn't complete – you need to include a topic sentence.' This they claim would be classed as feedback as it indicates to the student what they have done and what else they could do in respect to the learning goal.*

> *'Bianca, you got 8/10 on your spelling test.' This is an evaluation and they claim would not be classed as feedback as it gives the student no insight into how to improve.*

Therefore, unless the feedback message includes useful information related to learning goals, supports students' learning and can be utilised to improve their learning, then for this study those communications would not be classed as feedback.

As feedback is integral to learning, the person best placed to indicate what has helped their learning is the learner himself or herself. Therefore, it was considered of extreme importance in this study to ask students what information had been provided that they perceived had helped their learning, in particular from oral interactions with the teacher. Consequently, the analysis of students' perceptions against the theoretical conceptualisation of feedback will provide illumination as to types of oral interactions within science classrooms that have the potential to

support learners. It is the actualised types of oral communications that are perceived by students as being beneficial to learning in science, and related to goals that will hence be classed as oral feedback in this study. Students' perceptions and oral interactions will be examined in detail in Chapter 5. The next section explores some of the various dimensions associated with feedback that are claimed to enable the more effective utilisation of it for promoting learning.

2.7 Feedback Dimensions

Throughout the literature there are a number of different dimensions associated with the implementation of feedback that are argued improve the efficacy of it as a mechanism for promoting students' learning. The following section will examine some of these different facets and establish the models of feedback that will be utilised when analysing the classroom practice of the teachers who were observed in this study.

2.7.1 Feedback Conditions

Ramaprasad (1983) emphasises three points relating to his definition of feedback. The *first* is that the focus of the feedback may be any system parameter: input, process or output. Ramaprasad (1983) claims this broadens out the previous work around feedback that focused in the main on output parameters. His *second* crucial point was that there are three necessary conditions for feedback, which he lists as: (1) the existence of data on the **reference (desired) level** of the parameter. (2) Data on the **actual (current) level** of the parameter. (3) A **mechanism for comparing** the two to generate information about the gap between the two levels.

Ramaprasad (1983) argues that if one or more of these three conditions is absent, then there cannot be feedback, as it will render the feedback process ineffective. Ramaprasad (1983) notes that what he refers to as the 'reference levels' are named as the 'goals' by others. Sadler (1989) reasons that the reference level becomes a goal when it is desired or aspired to by the learner, and contends that the indispensible conditions for improvement mean that the student has to possess the same concept of quality in terms of these three conditions as the teacher. Sadler (1989) also argues that these conditions must be satisfied simultaneously rather than as sequential steps. However, as has already been argued when defining feedback for this study, there is the possibility that students can benefit from feedback, even if not all three conditions for improvement are simultaneously present.

The *third* point raised by Ramaprasad (1983) relates to the accuracy of the data gathered on the reference level and actual level of the focal parameter. He argues that as well as needing all three of the conditions satisfied, in order for the feedback to function at its most effective, then both values need to be as accurate as possible. Ramaprasad (1983) contends that if both data are inaccurate then the feedback process would be meaningless, and if only one of the two levels is inaccurate then the effectiveness of the feedback will be reduced, and the biases of the comparator will affect the measurement of the gap between the actual and reference levels.

The idea that the accuracy of information relating to the focal parameters is important, but suggests a narrow view of feedback that links to the more linear and behaviourist conceptualisation of learning, and is therefore limiting in respect of the potential efficacy of feedback to help students learn. Contrary to Ramaprasad's conditions, there is the possibility that feedback can still have meaning and enhance learning for an individual despite the accuracy of the reference and actual levels of the focal parameter. For example, a learner working independently in the *Zone of Proximal development* may receive feedback as a consequence of the work they are undertaking. Even though they may have no idea regarding the accuracy of any parameters, they is still the potential for them to be able to utilise the feedback information to influence future actions and consequently improve their learning and performance.

Another point made by Ramaprasad (1983) is that even if all three conditions are satisfied, and accurate information on the gap between the actual level and the reference level is identified, this would still not be classed as feedback. Sadler (1989) raises a concern that when teachers provide students with valid and reliable judgements about the quality of their work, improvement does not necessarily follow. He argues that students often show little or no growth or development despite regular, accurate feedback, arguing this can be frustrating for teachers and students alike. Ramaprasad (1983) affirms that the information can be called feedback only if, and when, the information results in action being taken by the student to alter the gap. He states that if the information is stored in memory it is not feedback. However, in comparison to the conceptualisation of constructivist learning theories identified as being apposite in supporting students' learning in science, the notion of assessing actual and reference levels of performance within feedback in order to identify gaps is limiting. The idea of learning developing for the learner on various horizons (James, 2006; James & Lewis, 2012; Torrance, 2012)

may mean the conditions conceptualised by Ramaprasad are restrictive in terms of feedback that supports students' learning.

The concept of students having to act on the information to improve their learning (Ramaprasad, 1983; Sadler, 1989) links to the conceptualisation of feedback constructed in this study and again emphasises the importance of the student being active and responsible for constructing meaning during feedback. There are a number of different aspects relating to feedback conditions proposed by Ramaprasad (1983) and Sadler (1989), it will, therefore, be of interest when analysing students' perceptions of what helps them learn in science to note which of these conditions, if any, they identify.

2.7.2 Feedback Models

> *Feedback is one of the most powerful influences on learning and achievement, but this impact can either be positive or negative. (Hattie and Timperley, 2007, p. 81)*

Hattie and Timperley (2007) proposed a model for effective feedback drawing on constructivist theories that aim to provide information to the teachers and/or students about the content and/or understanding that students have made from the learning experience. The model they propose is not the same as a behaviourist input-output model, as the feedback can be accepted, modified or rejected by the learner as they construct meaning from it. Hattie and Timperley (2007) link their model to the ideas proposed by Ramaprasad, as they declare that feedback should be used to reduce discrepancies between current understandings and performance and a goal. Hattie and Timperley (2007) propose a model for effective feedback in which three questions, which can be posed by the teacher and/or student, must be addressed. These questions they state "correspond to the notions of feed up, feed back, feed forward" (p. 86). Figure 2.3 is a synthesis of the ideas proposed by Hattie and Timperley (2007) and Ramaprasad (1983) and illustrates how the feedback models intersect.

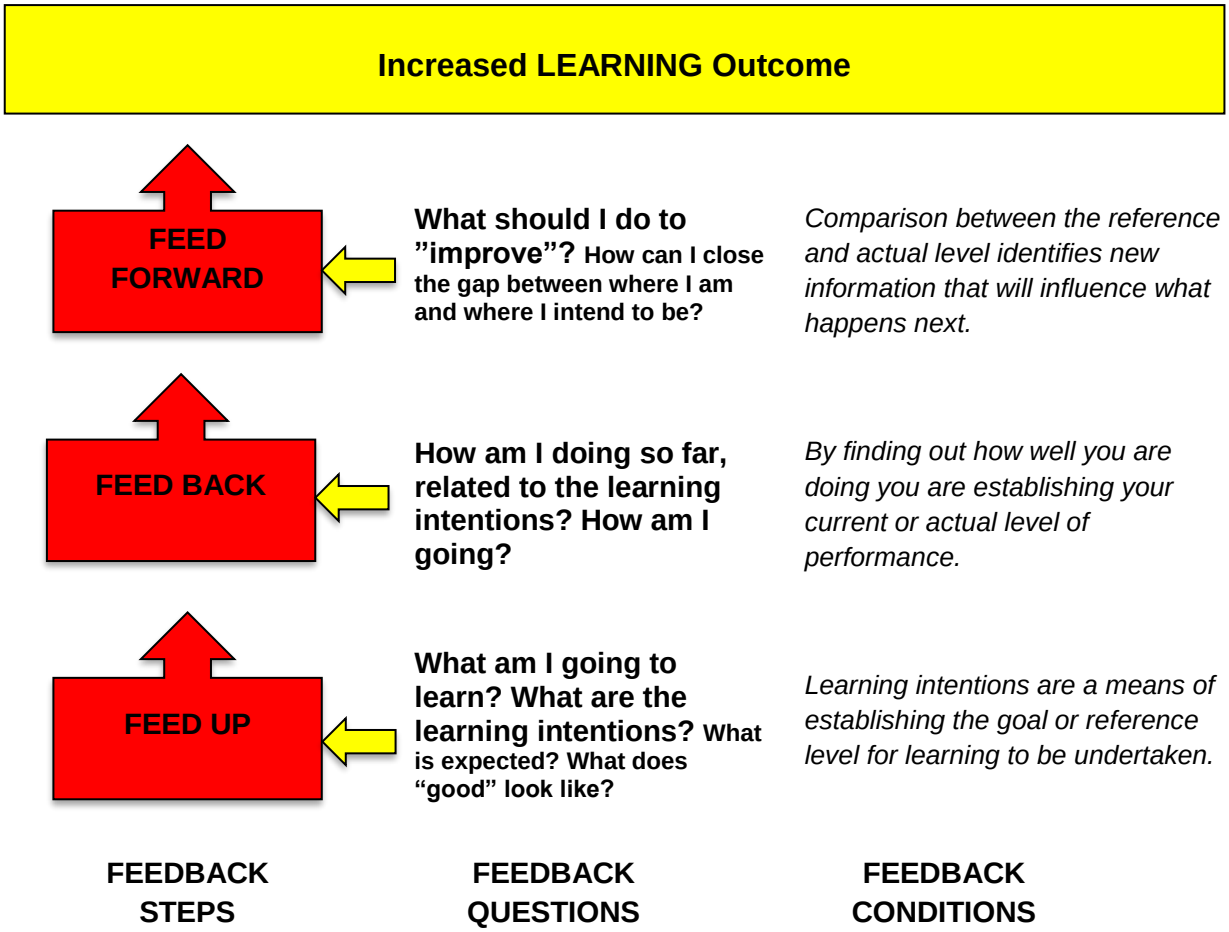


Figure 2.2 Feedback dimensions

Jones and Meling (2012) claim that the feed forward phase is usually seen as one of the most important elements, as this is the aspect of assessment practice that creates the shift from the traditional assessment of learning to the expanded concept of AfL, where learning, assessment and feedback coalesce for the learner's benefit. Jones and Meling (2012) discuss how in terms of their model it is the teacher who provides the learner with the appropriate information that might facilitate progress in order to increase learning. This is a notion that will be challenged when the role of the teacher and student are explored within the constructivist, divergent framework of feedback presented in this study.

Table 2.5 shows the interface between the concept of feedback loops from Goetz (2011), as discussed previously in section 2.5, and the model of effective feedback propositioned by Hattie and Timperley (2007).

Feedback to Improve Students Learning	Feedback Loops to Affect Changes in Behaviours
1. Feed up – what am I going to learn, what are the learning intentions/goal?	
2. Feed back - How am I doing so far related to the learning intentions?	1. First stage – the evidence stage 2. Second stage – the relevance stage
3. Feed forward – what should I do to improve?	3. Third stage – the consequence stage
4. Formative Functioning Feedback - student acts	4. Fourth stage: the action stage

Table 2.5 Interface between feedback process and feedback loops

The one distinct difference between the two models is that the goal is not specified in the definition provided by Goetz (2011). However, in Goetz's construct, this is implicit, as the aim of the feedback loop is to operate as a mechanism to help the individual move towards their goal. The next section explores two specific feedback models related to these dimensions of feedback.

2.7.2.1 *Discrepancy* and *Progress* Feedback

The concept of feedback across the literature is univocal in that it advocates the notion that feedback is most effective when utilised to reduce the discrepancies between current understanding or performance and some desired level of performance or learning goal (Black & Wiliam, 1998b; Hattie & Timperley, 2007; Kluger & DeNisi, 1996; Shute, 2007, 2008; Voerman et al., 2012, 2014). In addition to this is the idea that as well as identifying the discrepancies, feedback should also include information of what needs to be undertaken in order to achieve the desired level. In terms of goal-related feedback there are two distinct models. One relates to what is yet to be achieved, and is therefore associated with the 'what should I do to improve?' question (Hattie & Timperley, 2007), with this specific type of feedback labelled "*discrepancy* feedback*"* (Voerman et al., 2012, p. 1109), whereas the alternative specific type affords learners the details regarding the progress they have made towards the goals and what has already been achieved, and is therefore associated with the 'how am I doing so far?' question (Hattie & Timperley, 2007), and is labelled *progress* feedback (Gipps et al., 2000; Schunk & Swartz, 1993;

Svanes & Skagen, 2016; Voerman et al., 2012, 2014). How both types relate to the ideas proposed by Ramaprasad can be seen in Figure 2.3, in the feedback model proposed by Voerman et al. (2012).

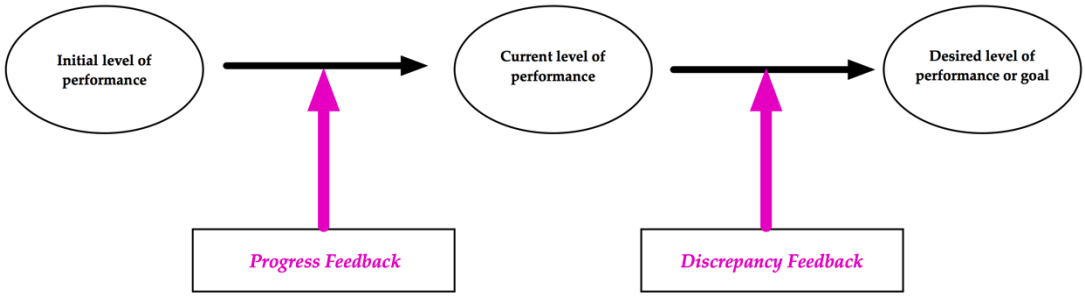


Figure 2.3 Voerman et al. (2012) *progress* and *discrepancy* feedback model

Whilst most of the feedback literature proposes that *discrepancy* feedback has the biggest influence on improving learning and/or performance (Carnell, 2000; Hattie & Timperley, 2007; Kluger & DeNisi, 1996; Shute, 2007, 2008), there are some who contend that *progress* feedback is more influential in improving students' learning strategies and motivation (Schunk & Swartz, 1993; Schunk & Ertmer, 1999). However, the contexts in which *progress* feedback has been cited as being beneficial are more limited, and were associated with the acquisition of writing achievement and computer skill acquisition. Within the conceptualisation of feedback theorised by this study, whether either one by itself, or both of these two specific goal-related feedback types are perceived as being beneficial to the learning of students in science, will be examined and compared to the findings espoused here.

2.7.3 Feedback Foci

Tunstall and Gipps (1996) conducted extensive fieldwork collecting between 24-36 hours of classroom data for each of the eight teachers involved in their study. Classroom interactions along with teacher and student interviews were recorded and analysed. From this analysis they proposed a typology of feedback (1996) that included feedback which was: verbal and non-verbal; distinctly positive or negative; process or product related; based on the use or non-use of explicit criteria; given to individual children; and used as part of classroom management. Interestingly they claim these types essentially emerged from the data. Tunstall and Gipps (1996) state that the examples given, and the emphasis on verbal feedback, are specific to this age group of children as the classrooms they exist in are very verbal in nature

due to the young age of the children (5 to 7 year olds). However, Tunstall and Gipps claim the overall frame of the typology can be extended to teacher feedback with other age groups. Gipps et al. (2000) conducted further research and updated the work of Tunstall and Gipps (1996), adding specific feedback strategies that teachers were seen to employ related to the typology. Figure 2.4 summarises the Tunstall and Gipps (1996) and Gipps et al. (2000) teacher feedback typology, with dedicated feedback types in **bold** and feedback strategies *italicised* for the different typology categories.

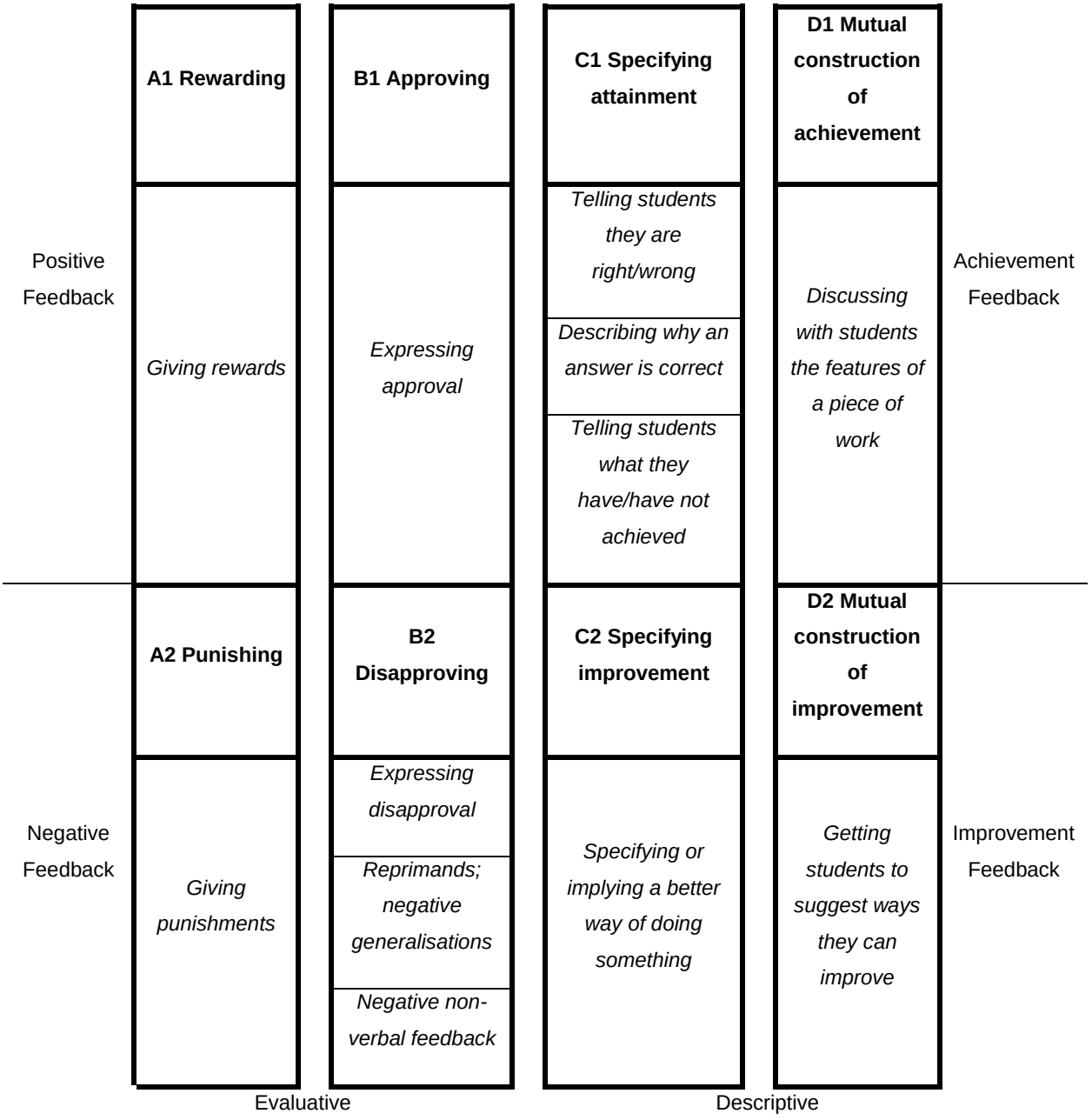


Figure 2.4 Tunstall and Gipps (1996) and Gipps et al. (2000) feedback typology

From the evidence presented, the typology produced does not cover every type of oral interaction that occurs within the classroom and is therefore at risk as an instrument of 'missing' some forms of data pertaining to oral interactions that may be of interest, such as questions asked by the teacher. The typology offers a continuum of interactions that occur within the classroom that range from being *evaluative* (judgemental) at one end to *descriptive* (competence-related) at the other. The spectrum of feedback types range from those that focus attention towards the self at the *evaluative* end, to those that focus attention towards the task and learning methods at the *descriptive* end. From the conceptualisation of feedback proposed for this study, the Tunstall and Gipps (1996) *evaluative* Type A and Type B categories would not be conceived as being feedback. This is because they offer an evaluation of the student or their work and as such do not provide useful information related to learning goals (Wiggins, 1997, 2012, 2016), and therefore with regards to the definition proffered by this study would not be classed as feedback.

The inclusion of information relating to learning goals has been identified as a key aspect of the interactions that are classed as feedback in this literature review. Consequently, the Tunstall and Gipps (1996) Type C and Type D *descriptive* categories have the potential to function as feedback as they involve discussions relating to learning goals and more affective and conative (effort-based) aspects of learning. In relation to learning theories, the Type C categorised interactions ally with more traditional behaviourist and convergent approaches as the teacher is in control and ascribes the focus of the feedback, whereas the Type D interactions incorporate aspects related to constructivist and divergent theories, in which both the teacher and the student have responsibility and are co-involved in ascertaining the focus of the feedback. Tunstall and Gipps (1996), when summarising findings from their research, which included some analysis of oral feedback in the classroom, discussed how it was not within the scope of their study to analyse each teacher's feedback in depth, nor to evaluate the impact of the feedback on children's learning. They claimed that this remained as work for the future.

From their analysis of the 131 studies, Kluger and DeNisi (1996) demonstrated how feedback interventions could produce negative effects. They claimed many researchers who had assumed that feedback interventions consistently improved performance had largely ignored these. Wiliam (2018) argues

that the ambiguous and contradictory findings on feedback interventions reported across the research literature could in part be due to the focus of studies being associated with performance, rather than with understanding the circumstances under which feedback improves learning. According to Kluger and DeNisi (1996) there are certain foci that are claimed to make the likelihood of either outcome more or less likely. Feedback interventions change the locus of attention among three general and hierarchically organised levels of control. These levels are; task learning processes (goals), task motivation and meta-tasks (including self-related) processes (Kluger & DeNisi, 1996). They assert this hierarchy of processes is an abstraction and in reality is probably more complex and contains more sub-levels. However, they avow that the results suggest that feedback interventions' effectiveness attenuates as attention moves up the hierarchy closer to the self-related processes and away from the task. Conversely, if the foci of feedback direct attention to task motivation or task learning processes, then there is the possibility of augmenting effects on performance. Therefore, if a feedback intervention directs attention up the hierarchy it may interfere with a students' ability to learn.

Kluger and DeNisi (1996) highlighted that the foci of a feedback intervention affected task motivation and learning depending on whether the current performance of the learner was higher or lower than the goal being addressed. Their findings on the possible responses from a learner to the feedback received linked to goal performance have been assimilated in Table 2.6.

Response Type	**Feedback indicates performance exceeds goal**	**Feedback indicates performance falls short of goal**
Change behaviour	Exert less effort	*Increase effort*
Change goal	*Increase aspiration*	Reduce aspiration
Abandon goal	Decide goal is too easy	Decide goal is too hard
Reject feedback	Ignore feedback	Ignore feedback

Table 2.6 Possible responses to feedback

Only the two italicised responses, *increase aspiration* and *increase effort*, are likely to improve performance, with the other six at best doing nothing, and at worst lowering performance (Kluger & DeNisi, 1996). Kluger and DeNisi (1996) also state that the feedback interventions should be accompanied with "cues helping to

reject erroneous hypotheses*"* (p. 265)*.* If this additional guidance is absent, they claim that it may cause the recipient to generate a multitude of hypotheses that can reduce consistency and reduce performance. In other words, feedback interventions need to focus the learner not only on task learning processes, but they also need to provide accurate information as to which resulting strategies would be the most beneficial for the learner to pursue; conditions of feedback alluded to previously (Hattie & Timperley, 2007; Ramaprasad, 1983; Sadler, 1989).

From this analysis, the research indicates that feedback that is more likely to result in improved learning and/or performance should focus on learning processes and support the learner by: providing a recipe for future action; encouraging those that are falling short of the desired goal to increase their effort; and encouraging those exceeding the desired goal to aspire to do even more. If feedback does not focus on such aspects of learning and confer the behaviour changes required from students, the effects to performance could be detrimental (Chappius, 2012; Hattie, 2012b; Kluger & DeNisi, 1996).

The ideas of different levels of focus associated with feedback, concurs with the 'Four Levels' proposed by Hattie and Timperley (2007) (1st, task; 2nd, process; 3rd, self-regulation; 4th, person/self). The four levels of Hattie and Timperley (2007) correspond in all respects with those identified by Kluger and DeNisi (1996), except that they have an additional level associated with feedback about the person. Hattie and Timperley (2007) claim this additional level is the least effective of all the feedback foci, and feedback related to self-regulation and process is the most effective. This concurs with the ideas suggested by Kluger and DeNisi (1996) that feedback focused on task motivation or learning processes can augment performance.

It is therefore important for this study to ensure that all oral interactions that occur within the science classrooms, along with students' perceptions of any perceived as beneficial for learning, are analysed. Whether the students in this study identify any of these foci as effective will be reported when their perspectives are explored. As this study aims to draw on both students' and teachers' perspectives concerning perceived beneficial aspects of oral practices, to develop knowledge about feedback that works for students in science classrooms, current thinking identified by research regarding the roles of teachers and students within feedback will be explored further in the following sections.

2.8 The Role of the Teacher Within Feedback

The part that both teachers and students play in supporting the learning process requires a change if a teacher's core aim is to be achieved, namely, enhancing students' learning. This rethink calls for a shift in the behaviours that both parties undertake so that the emphasis is clearly on learning being actively constructed by the student (Black et al., 2002). Understanding teachers' feedback practices, as part of this learning process is an important starting point for studies that examine the impact of oral feedback on learning. The following section reviews literature associated with the teacher's role in feedback, firstly at the basic mechanistic level exploring practicalities of how feedback can be provided so that it is accessible for the learner, then at the more advanced level considering how teachers' behaviours and beliefs can affect how they utilise feedback to nurture students' own learning capabilities.

2.8.1 Providing Feedback Accessible to the Learner

The accessibility of feedback is multidimensional, and there are a number of different factors that research highlights that enable it to become more comprehensible to the learner. Some of these include it being: (1) specific and useful to the student in that it provides 'quality' guidance on how to improve linked to learning goals. (2) Appropriate in length and complexity of language. (3) Timely.

According to Poulos and Mahony (2008), the use of the word 'effective' in the context of feedback has been associated with that which is both appropriate and timely and suited to the needs of the situation. Poulos and Mahony (2008) state that the meaning applied to 'appropriate' varies, and some of the factors researched include: sufficient (Holmes & Smith, 2003); face-to-face (Hebert & Vorauer, 2002); and instructor-delivered (Riccomini, 2002). Poulos and Mahoney (2008) suggest that most of the research on appropriate feedback to students has focused on the input side of the equation: what is provided to students, how it is provided and when, a view again linked to the traditional behaviourist input-out model of feedback.

A crucial issue in teachers' effective use of feedback is its quality, where quality is in part linked to working with clearly defined standards that do not default to an existentially determined baseline derived from how other students perform (Sadler, 1989). In other words, it is important that feedback is not about providing information which judges and ranks students against each other as a way of norm referencing them, and instead is about providing individual tailored guidance for

each student on how they need to progress in order to improve their current performance (Sadler, 1989).

However, Sadler's model belies a linear approach to learning linked wholly to performance and does not encompass the complexities of building understanding and meaning, an aspect of learning that is particularly multifaceted in science. Therefore specific and useful feedback needs to be more than teachers providing task-related, standards-oriented feedback tailored to the individual's performance in order that improvement can be plotted for each student (Sadler, 1998). It requires teachers accurately assessing where the student is at in their learning, and tailoring the feedback to individual learning needs, in order to ensure appropriate specific guidance is provided to students that they understand related to why (work/learning) was good or bad, directly linked to the learning objective with recognition of criteria met (Hargreaves, 2011). As discussed previously, a further way of improving the quality and therefore the usefulness of the feedback, is to include the student in selecting and negotiating goals relevant to them (Butler & Winne, 1995; Hargreaves, 2011; Pryor & Crossouard, 2008). However, if inaccurate assessment has taken place, then the feedback provided would be at a level incompatible with where the student is at in their learning (Chappuis, 2012; Orsmond, Merry and Reiling, 2005; Wiggins, 2012, 2016).

A further factor obstructing students' accessibility to learn from feedback provided by teachers is linked to feedback complexity, i.e.: how much, and what information, should be included in the feedback message (Orsmond et al., 2005; Shute, 2007, 2008). The complexity of teacher feedback language could be because it is vague and unfamiliar to the student, thus limiting their understanding of what is being articulated. The complexity could also be related to the quantity of both positive and negative feedback being provided by the teacher and become overwhelming for the student so that they are unable to take it in (Orsmond et al., 2005; Shute, 2007, 2008). Shute (2007, 2008) acknowledges that feedback provided by the teacher that is too long may diffuse or dilute the message, or be ignored.

Another facet of feedback that can fall under the jurisdiction of the teacher is the timeliness of when they provide it to the student. In terms of what research has evidenced is the appropriate time to provide feedback to the learner, there have been conflicting results. Researchers have been examining the effects of immediate versus delayed feedback for decades, and there is still a lack of clarity between the

relationship of feedback timing and learning/performance (Shute, 2007, 2008; Hargreaves, 2011). *Immediate* is defined as “right after a student has responded to an item or problem”, and *delayed* as “relative to *immediate*, with such feedback occurring minutes, hours, weeks or longer after the students completes the task or test” (Shute, 2007, p. 15; 2008, p. 163).

There are supporters from research for both of the timings, those who affirm that *immediate* is better, theorise that the earlier that corrective information is provided, then the more likely it is that efficient retention will result. This has been evidenced in studies looking at the acquisition of verbal materials, procedural skills, as well as some motor skills (Chappuis, 2012; Shute, 2007, 2008). Those who are advocates of *delayed* feedback generally adhere to the interference-perseveration hypothesis proposed by Kulhavy and Anderson (1972). The hypothesis asserts that initial errors do not compete with to-be-learned correct responses if corrective information is delayed. In other words, mistakes are most likely to be forgotten and as such cannot interfere with retention (Shute, 2007, 2008). This hypothesis has been evidenced in studies (Kulhavy & Anderson, 1972; Surber & Anderson, 1975), comparing the accuracy of responses on a retention test with those on an initial test (Shute, 2007, 2008). Although there is no real clarity as to which is the better timing for providing feedback, both *immediate* and *delayed* feedback have been shown to be as effective as each other (Shute, 2007, 2008).

Interestingly, the findings reported by Orsmond et al. (2005) relate to work they conducted examining lecturers’ and students’ perceptions of written feedback. One of their discoveries was that what students really seek is a dialogue with tutors about their work rather than written feedback, and this, they claim, supports previous research (Orsmond et al., 2005). Other studies examining teachers’ perceptions have identified similar preferences for classroom educators, who also stress the importance of feedback occurring during the learning (Gipps et al., 2000; Hargreaves, 2011). One could surmise that oral feedback is more likely to occur during the *immediacy* of the learning/performance, whereas written feedback tends to come under the jurisdiction of *delayed*. However, this may not always be the case.

One study of particular interest is that carried out by Boulet, Simard and De Melo (1990). This study does not relate to secondary science classrooms; however, it is of importance as it aimed to address the effectiveness of oral versus written feedback. Boulet et al. (1990) studied how 80 secondary music students performed

as they were being taught a mastery learning approach to writing major scales. Boulet et al. (1990) state the theory of mastery learning is based on the theoretical premise that all students can learn when provided with conditions appropriate for their learning, and where basic and critical elements of it are feedback and correctives. Boulet et al. (1990) ensured that all students received the same teaching related to the writing of major scales and split the students into three groups, with one group receiving oral feedback, one written and the final control group no feedback at all. Control variables were identified (previous academic success, musical aptitude, ability to learn) and analysed to try and ensure comparability across the three groups, and the validity and reliability of the tests were established during a pilot study. Boulet et al. (1990) used five different statistical measures to ascertain the effect that the different forms of feedback had on performance of the task. Even though all groups fell short of the mastery level of success set for the writing of scales task, the only group that realised a statistically significant improvement of learning was the group that was given oral feedback. From their analysis they also showed that there was no statistically significant difference in performance between the group given written feedback and the control group who were given no feedback at all.

It is difficult from the study to establish what exactly caused the difference in levels of learning for the oral feedback group, as the groups were treated differently after feedback had been given. For example, those that were given oral feedback were allowed time in class to correct the identified errors in their learning whilst those in the written feedback group were provided with a step-by-step work plan with a blank copy of the test for the student to complete independently. Boulet et al. (1990) conclude that oral feedback represents one solution but not necessarily the best one and more research must be done. Nevertheless, what is more important than the form the feedback takes is the fact that students have the opportunity to improve their work (Brookhart, 2012; Chappuis, 2012; Dann, 2018; Wiliam, 2011). It seems reasonable that set-aside time where students act on feedback could be beneficial to them; whether they are given oral or written feedback, the opportunity to ensure that action is taken is the key. Feedback needs to include the students generating their own goals and acting on the guidance provided (Hargreaves, 2011), and leaving students to do this outside of lesson time may be a factor that affected the results seen by Boulet et al. (1990).

Nonetheless, the effectiveness of feedback may not depend on the main effect of timing, but on the nature of the task, and social and personal factors

affecting the capability of the learner in relation to the feedback timing (Shute, 2007, 2008; Hargreaves, 2011). There is the possibility of both negative and positive learning effects for either *immediate* or *delayed* feedback. These effects are dependent on the complexity of the task and the capability and motivation of the learner (Shute, 2007, 2008).

The characteristic of timeliness in terms of effective feedback is therefore a complicated and multi-faceted one. However, Kulik and Kulik (1988) from their meta-analysis of research reviewing the timing of feedback demonstrated that even though results were varied, where studies had investigated feedback in real classrooms, *immediate* rather than *delayed* was more beneficial for the learners. Kulik and Kulik (1988) concluded that "delayed feedback appears to help learning only in special experimental situations and that, more typically, to delay feedback is to hinder learning" (p. 94). This concurs with the review by Elliott et al. (2016) that "studies of verbal feedback indicate that learners find it easier to improve if their mistakes are corrected quickly" (p. 22). However, there is a paucity of research examining the timeliness of feedback in school classrooms and it is an area that warrants further research (Elliott et al., 2016). Consequently, the characteristics associated with oral feedback identified by this study 'during the learning' will add to the knowledge in the field.

2.8.2 Promoting Student-directed Learning

In order to achieve the more progressive purposes of education, teachers need to nurture students' autonomous self-directed learning capabilities (Hargreaves, 2013, 2014), with autonomous learning defined as the student taking the initiative, acting independently, assuming a critical stance or at best a combination of these three aspects (Ecclestone, 2002; Dann, 2015a; Plank, Dixon & Ward, 2014). Developing self-learning qualities in students requires teachers utilising feedback in a way that is more than just convergent practices of providing lists of goals, standards, criteria or controlling behaviour, and instead utilising divergent approaches to promote student-directed learning and nurture a deep appreciation of how complex qualitative judgements can be made. Such approaches to the implementation of feedback are more likely to contribute to the development of learner autonomy (Hargreaves, 2013, 2014; Hattie & Timperley, 2007; Sadler, 2010; Torrance, 2012; Vercauteren, 2009).

Factors that impact on the quality of feedback and fall under the influence of the teacher are therefore, not just the technical structure of the feedback (such as

its accuracy, comprehensiveness and appropriateness). Other aspects of effective feedback are influenced by social and personal factors related to supportive learning environments, where relationships are trusting, with all parties seen as learners (Hargreaves, 2011). In such environments the feedback process is made accessible to the learner, with students own values and goals driving the agenda (Hargreaves, 2011), and its catalytic and coaching value, its capabilities of nurturing independent, autonomous learners and its ability to inspire confidence and hope are all nurtured (Sadler, 1998; Torrance, 2012).

Cognitive engagement is key to both students' autonomy and the wider goal of improving student learning (Bryson and Hand, 2007; Butler & Winne, 1995). Bryson and Hand (2007) distinguish between surface (superficial) and deep approaches to learning, and argue that deep approaches are connected to qualitatively superior outcomes associated with understanding a subject. They argue, a continuum of conceptions moving from teacher-centred-content-orientation (TCCO) to student-centred-content-orientation (SCCO) approaches exists and is linked to teacher's beliefs. They claim the TCCO conception aligns with behaviourist authoritarian learning theories, whilst SCCO ideas are affiliated with constructivist ones. Teaching approaches based on SCCO appear to contribute towards deeper and improved learning by the students; and include "interaction, problem-centered assessments, a high degree of learner activity (doing), and learner choices" (Bryson and Hand, 2007, p. 351).

How a teacher communicates during teaching can affect student engagement in the learning process. Directive styles of communication differ from interactive styles, and are associated with adults telling students what to do rather than facilitating discussions by making suggestions and asking questions to engage with learners in joint activities (Bruner, 2001; Tunstall & Gipps, 1996). Hence, directive styles of communication are coupled with transactional information that is unidirectional. Conversely, interactive styles support students to generate their own solutions, either by not giving answers or through promoting self-directed learning and can be seen as way to help learners develop self-monitoring strategies. Directive approaches therefore link to a behaviourist conceptualisation of learning, whereas interactive styles associated with a constructivist conceptualisation of learning. Interactive styles are more effective in facilitating learning than directive and are evidenced when adults "do not talk at children, but with them" (Bruner, 2001, p. 57). An interactive approach to feedback would provoke students to consider concepts independently and provide strategies so they can develop or

assess their own work, and according to the literature seems to have the most potential for advancing students' self-autonomy (Hargreaves, 2014; Hattie & Timperley, 2007; Tunstall & Gipps, 1996).

Hardman (2016b) refers to tutor-student interactions that are directive in nature being associated with teaching styles in which little use of effective questioning techniques are utilised and there is not enough engagement with students in terms of oral feedback. The types of, and utilisation of, questions asked by teachers as part of developing classroom feedback in science is one way to make students think. Such feedback can provoke thoughtful answers, prompt further engagement and empower students to become self-directed and responsible for their learning. Errors to responses can be treated as miscues, valued for the insights they afford into how learners are thinking instead of being dismissed (Chappuis, 2012; Hattie, 2012; Pryor & Crossouard, 2008), all of which are aspects of divergent, constructivist learning approaches. This in turn has the potential to engender self-feedback, therefore building student-directed learning capabilities.

However, there is disagreement as to whether questions can operate as a mechanism for feedback. Some researchers claim that questioning is a form of instruction rather than feedback (Knight, 2003; Voerman et al., 2012). Nonetheless, Knight did not make any distinction regarding the types of questions analysed, and Voerman, et al. (2012) indicated that questions might be perceived as feedback if viewed from the perspective of the student rather than that of the teacher as they may help shift students' focus towards goals. Interestingly, Voerman et al. in their analysis were justifying their standpoint from just the perspective of the teacher and did not include that of the students (2012). Several other studies and authors have referred to the beneficial use of divergent and open questions in feedback (Brookhart, 2012; Dann, 2018; Elliott et al., 2016; Gipps et al., 2000; Hargreaves, 2013, 2014; Hargreaves et al., 2000; Torrance & Pryor, 2001). Elliott et al. (2016) stated that the lack of high quality evidence focusing on student outcomes make it challenging to reach conclusions. However, they state that "use of teacher questions in feedback can help clarify understanding and stretch students" (p. 18). It will therefore be of interest in this study to identify whether convergent or divergent questioning supports students by providing useful information linked to learning goals as a form of feedback rather than just a mechanism for giving instructions, and whether any types of questioning support self-directed learning capabilities.

A teacher's beliefs can influence the way they ask questions and how they interpret answers (Black & Wiliam, 1998b). By utilising appropriate questions, the teacher has the opportunity to reflect and pay attention to what they do with those answers in the follow-up move. Several ideas of how teachers can follow-up which will benefit student-directed learning are suggested by Hardman et al., (2008), and include asking students to expand on their thinking, justify or clarify their opinions, or make connections to their own experiences. However, Hardman and Abd-Kadir (2010) highlight one kind of classroom talk that international research has shown predominates teacher-student interactions at all phases of education which is limiting in terms of building students' understanding and self-learning capabilities. They call this the 'recitation script', made up of teacher explanation and closed teacher questions, brief student answers and minimal feedback (also known as triadic dialogue, Lemke, 1990), which requires students to report someone else's thinking rather than think for themselves.

Wilson (1999) discusses the prevalence of this recitation script amongst practitioners they were investigating, and asserts that many investigations have shown that more than 50% of exchanges between teacher and students are triadic in nature (Cazden, 1986; Edwards & Mercer, 1987; Mehan, 1979; Wells, 1999). Triadic dialogue constitutes IRF or IRE patterns of talk; where I corresponds to the *initiation* of the dialogue by the teacher, normally with a question; R is the student's *response/reply*; and F is the *feedback* from the teacher or *E* teacher *evaluation* of how well the student's response met their expectation (Cazden, 1986; Cazden & Beck, 2003; Edwards & Mercer, 1987; Hargreaves, 2016; Mehan, 1979; Sinclair & Coulthard, 1975; Viiri & Saari, 2006; Wellington & Osborne, 2001). Ruiz-Primo & Furtak argue that feedback within IRF sequences is more general in its interpretation. They claim such interactions are often characterised by the teacher using inauthentic answers, where they already know the answer, as pretence of creating classroom dialogue rather than a monologue (2007). This conception of feedback aligns to convergent practices and more behaviourist authoritarian contexts, with information provided by the teacher to the student that may constrain or threaten the autonomy of the learner (Hargreaves, 2012, 2016; Ruiz-Primo & Furtak, 2007). This type of feedback interaction may or may not align to the conceptualisation derived in this study, depending on the content of the interaction.

Scott, Mortimer and Aguiar (2006) propose alternative types of talk pattern that they claim are non-triadic in nature. Examples of such non-triadic oral interactions that they claim normally generate chains which take an I-R-P-R-P-R-

form (where P stands for Prompt). Here the prompt move by the teacher is followed by a further response from the student [R] and so on. Some chains of interaction are closed by a final evaluation from the teacher (I-R-P-R-P-R-E), whilst others remain open without any final evaluation (I-R-P-R-P-R-). Hardman et al. (2008) state that teachers who employ open thought provoking questions could transform classroom talk from the familiar IRF sequence into purposeful and productive dialogue with their students. Hardman (2016a) argues that employing such strategies "can help to open up and extend classroom discourse, facilitate knowledge accumulation and a shared understanding, and encourage genuine communication and critical thinking" (p. 11). Such practices link to divergent approaches to feedback and are affiliated with constructivist views of learning and are more likely to support students in developing self-directed learning capabilities. However, it cannot be claimed that talk patterns that involve the use of open questioning and consist of longer sequences of oral interactions, can be asserted to be feedback. Nonetheless, it is suggested that instances that demonstrate these characteristics are more likely to include oral feedback.

This study will concentrate on *immediate* feedback in the sense that it is aiming to establish the cogency of oral feedback that aligns to the conceptualisation of feedback theorised as supporting students' learning. There are a variety of different factors that fall under the dominion of the teacher within the classroom that interconnect, and have the possibility of affecting feedback that may benefit or be detrimental to the learner. It is therefore of interest to this study to analyse how the teachers conceptualise feedback, and whether their practices link to the theoretical definition derived from research or differ in any aspects. Moreover, in addition to the analysis of teachers' conceptions, it is important to explore teachers' practices associated with oral interactions, and whether any are perceived by students as helpful in promoting learning. The next section explores the literature relating to the student's role within feedback.

2.9 The Role of the Student Within Feedback

> *Students must think for themselves before they truly know and understand, and teaching must provide them with those linguistic opportunities and encounters which enable them to do so. (Alexander, 2014, p. 12)*

Having examined the literature to identify aspects of teachers' practices and beliefs associated with the effective use of feedback, the ensuing section explores features related to students. This examination is to consolidate understanding regarding the types of student behaviours reported as enhancing their learning associated with feedback.

2.9.1 *Dynamic* Co-agents

Blanchard (2008, 2009) conducted a five-year study developing formative practices, including the use of feedback, across a local authority (LA) involving teachers from 66 primary and secondary schools. The researchers "assisted and critiqued Portsmouth colleagues' planning, practice and self-evaluation in AfL and, to that end, helped them link with one another and with people outside the city engaged in similar work" (Blanchard, 2008, p. 139). Whilst the study did not provide any statistical evidence, it claimed that standards across the LA rose over the five years, with teachers attributing this rise wholly, or in part, to the project. Findings from Blanchard's (2008, 2009) research are qualified throughout, with extracts from teacher and student interviews. However, the evidence pertaining to aspects of feedback seen as beneficial to learners are very scant and in the main attributed to written practices.

As a result of his research regarding student involvement, Blanchard (2008, 2009) defines different levels of learner activity in formative practices building on the convergent and divergent theories postulated by Torrance and Pryor. Blanchard (2008, 2009) claims that, in its early stages, formative practice tends to affirm or introduce *transparency* (teachers in control, making clear such things as purposes and criteria for activities in lessons), and, given certain values and circumstances, this can grow into *interactivity* (learners taking an increasingly active role in deciding these things). He states that there is clarity in the first step, and shared decision-making in the second. Blanchard (2008, 2009) argues that this move from *transparency* to *interactivity* moves the students from being *passive* and dependent, to being more *dynamic* with their own sense of purpose and progress. Movement along this continuum can be seen as a shift away from the more authoritarian and convergent classroom, in which the teacher is overly dominant, to one in which there is collaboration in the constructing of meaning that is more aligned to constructivist and divergent learning environments.

Students being actively involved with the formative use of assessment, including the use of feedback, therefore has the potential to be a more *dynamic*

process, increasing students' responsibility for their learning (ARG, 1999; 2002b; Black & Harrison, 2004; Dann, 2018); one of the key features of learning identified in section 2.2. The involvement of the student in divergent feedback dynamically constructed through social contexts is important if they are to be as effective as possible in improving performance, and should not remain the sole domain and responsibility of the teacher (Dann, 2018; Hargreaves, 2012; Sadler, 1989). Nonetheless, improvement can occur if the teacher provides detailed remedial advice and the students follow it through (Sadler, 1989).

However, feedback cannot be seen as a one-way procedure; indeed, feedback is a two-way bi-directional exchange of information as a "dynamic generative process" (Plank, Dixon & Ward, 2014, p.107) with teachers and students learning from each other and action required from both parties (Dann, 2018; Vercauteren, 2009). Feedback functions between the co-agents as a mediating tool in which interpretations from all parties matter (Dann, 2018). As such a *dynamic* feedback process would involve student interpretation as part of a negotiated shared relationship between teacher and learner (Vercauteren, 2009).

Therefore, as well as being active in, and responsible for, their learning, the locus of responsibility needs to shift so that students are cognitively involved if feedback is to be more effective (ASHE-ERIC, 1986; Bates, 2016; Carnell, 2000; Dann, 2018; Hargreaves, 2013, 2014; Howard, 2014; Hargreaves et al., 2000; Nuthall, 2007; Schwartz, 1980; Vercauteren, 2009; Voerman et al., 2014; Watkins et al., 2002, 2007). Where "locus refers to whether the learner sees responsibility lying with them or with external factors" (Murtagh, 2014, p. 520). This would involve constructivist approaches to learning with the students responsible for utilising cognitive tactics and strategies to build meaning. Students' cognitive engagement and responsibility can be achieved by providing access to information and resources upon which processes of construction such as, generating the data on the actual level and acting as the comparator, can draw (Butler and Winne, 1995; Ramaprasad, 1983; Sadler, 1989).

As well as students taking cognitive responsibility, Blanchard concurs with Sadler (1989) that *dynamic* student engagement involves them being able to "judge the quality of what they are producing and being able to regulate what they are doing during the doing of it" (2008, p. 142). To develop these capabilities, teachers need to enhance students' capacity to understand and debate the key issues in a discipline, as well as comprehend the qualities of particular pieces of work

(Torrance, 2012). Vercauteren (2009) highlighted how this was not necessarily an easy undertaking for teachers, as they were more likely to assess quantity and presentation rather than the quality of students' learning.

For teachers' conceptions of quality are typically held, largely, in an unarticulated form, inside their heads as tacit knowledge, and through experience and collaboration, they develop the ability to make sound qualitative judgements that constitutes a form of guild knowledge, otherwise known as evaluative knowledge (Sadler, 1989). An instructional system with an exclusive reliance on teachers' guild knowledge works against the interests of the learner because it legitimises the notion of a standard baseline, which is subject to existential determination, i.e. grading to emphasise rankings or comparisons, which are inappropriate for promoting learning. Guild knowledge also keeps the concepts of the standard relatively inaccessible to the learner (Sadler, 1989). Reliance upon the evaluative judgements made by the teacher also maintains the learners' dependence on the teacher, and inhibits students from moving from *novices* (those unable to invoke the implicit criteria for making refined judgements about the quality of their work) to *masters* (those who have developed evaluative knowledge through experience) (Sadler, 1989). Students' evaluative knowledge can be cultivated by providing access to information and resources, upon which processes of construction, such as generating the data on the actual level and acting as the comparator, can draw (Butler and Winne, 1995; Ramaprasad, 1983; Sadler, 1989).

Interestingly, Sadler (1989) makes a distinction between feedback and self-monitoring in terms of the source of the evaluative information. Sadler (1989) argues that if the learner generates the relevant information, the procedure is part of self-monitoring. If, however, the source of information is external to the learner, it is associated with feedback. The goal of many instructional systems is to facilitate the transition from feedback to self-monitoring (Blanchard, 2008, 2009; Sadler, 1989). This will be an interesting facet of the teacher-student relationship to explore in this study, by identifying any practices that qualify or challenge aspects of this assertion.

A key premise therefore for effective feedback is that for students to be able to improve, they must work with the teacher to develop the capacity to monitor the quality of their own work during actual production and come to share the teacher's vision of the subject matter. This requires teachers to create a learning environment in which students are treated as apprentices engaged in authentic activities, if they are to move beyond their current level of competence (Hargreaves, 2012), as it is

the involvement of the student in this process that will ultimately lead to improved learning and performance (Sadler, 1989). In order to achieve this, the learner has to understand themselves their own learning progress and goals, which would involve them: (a) possessing a concept of the *standard* (or goal) being aimed for. (b) Comparing the *actual (or current) level of performance* with the standard. (c) Engaging in appropriate *action* that leads to some development of understanding (Black & Wiliam, 1998b; Dann, 2018; Gipps et al., 2000; Hattie & Timperley, 2007; Sadler, 1989).

It is by allowing learners to access evaluative experiences, in which they can employ multiple criteria relating to the quality of their own and others' levels of performance, that they develop their own guild knowledge and become masters taking responsibility for their own learning (Sadler, 1989; Yang and Carless, 2013).

> *In its most productive forms, feedback goes beyond the development of students' knowledge or skills in the direction of nurturing students' capabilities for individual judgment, problem-solving, self-appraisal and reflection. (Yang and Carless, 2013, p. 286)*

Moving from *novices* to *masters* should be the case for any instructional system designed to produce learner outcomes, which are judged qualitatively using multiple criteria. The corollary is that by not including authentic evaluative experiences in the instructional system then either an artificial performance ceiling is placed on many students, or their rate of learning is limited (Sadler, 1989). Not only has the practice of learners operating as *masters* been shown empirically to produce results (Sadler, 1989), it is also important for the student to build learning capabilities for lifelong learning (Sadler, 1998), one of the main purposes of learning espoused previously. However, Sadler (1989) notes that some resistance to this proposition can be expected, due to teachers' underlying beliefs that only they have the skills and expertise to evaluate student work.

Therefore, in order to develop evaluative knowledge and become *masters* in their learning, feedback has an instrumental role to play for both teachers and students. It needs to shift the locus of responsibility and engender the proactive participation of the student, with the teacher supporting rather than directing and

where both are discussing learning or improvement mutually, with students encouraged to make their own suggestions (Gipps et al., 2000; Hargreaves, 2011, 2012, 2013, 2014). Evaluative knowledge may be fostered through exposing students to evaluative experiences where they are cognitively responsible and active in making evaluative judgements about the quality of what they are producing, as well as being able to regulate what they are doing during the doing of it (Sadler, 1989), which in turn would support them to take responsibility for decisions that inform their activity including the actions they undertake (Blanchard, 2008). This *dynamic* feedback process involves teachers developing self-monitoring strategies within their students.

For this study, *dynamic* interactions involve students as co-agents as part of a negotiated shared relationship and decision-making between teacher and the learner (Agaton, 2016; Blanchard, 2008, 2009; Dann, 2018; Vercauteren, 2009). This includes the idea of the teacher supporting the student in developing tacit evaluative knowledge to generate ideas for what to do next (Sadler, 1989), on which the student subsequently takes action (Torrance, 2012). The teachers are neither the direct source of information, nor are they allowing the students to work in isolation to generate the evaluative knowledge on their own. Through experience and collaboration the teacher shifts cognitive responsibility, and enables students to develop their own tacit knowledge so that they can make their own qualitative judgements, and take responsibility for decisions that inform their activity, thus generating learner capability. Such *dynamic* interactions, constructing meaning between co-agents, aligns with the constructivist theories of learning discussed earlier and would entail utilising divergent feedback practices.

Conversely *passive* interactions in this study involve the teacher being in control as the authority figure. The teacher draws upon their tacit evaluative knowledge to dispense qualitative judgements and recommendations for the students who act as *passive* recipients (Blanchard, 2008, 2009), consequently acting on and implementing suggestions. This approach to feedback maintains reliance for the student on the teacher's expertise, as they continue to operate as novice learners, limiting their capacity to work autonomously (Sadler, 1989, Torrance, 2012). Teachers would draw on more behaviourist theories of learning and utilise more convergent feedback practices.

Each learner will receive and interpret feedback in his/her own way, which may or may not match the intentions of those who offered the feedback. This potentially locates feedback as one dimension of each learner's learning environment. It sets feedback as a form of communication within a space… that is both physical, cognitive, and about values as much as knowledge. It positions feedback as part of the actions of students as well as part of the actions of teachers. (Dann, 2018, p. 45-46)

The review of the literature indicates that students need not only to be actively engaged during feedback, they also need to develop behaviours which will help them effectuate deeper learning and more autonomous capabilities during it. This in turn will increase their agency as integral owners of their learning to internalise what is experienced through feedback so that it becomes part of their learning (Dann, 2018). Ways in which these aims can be achieved involve teachers affording students the opportunities to make constructive use of divergent feedback through monitoring the quality of their work at increasingly higher levels, and providing opportunities for learners to reason, argue and present their views in order to negotiate an agreed plan for action (Dann, 2015a; Vercauteren, 2009; Yang and Carless, 2013).

This review of the literature has considered the relationship between student and teacher during feedback, and indicates aspects of the process of which to be conscious when analysing the data in this study.

2.10 Classroom Feedback Research

What is highlighted by this study is the need to carry out more extensive and intensive research into teachers' verbal feedback and into how children perceive it and respond to it. (Hargreaves, 2014)

Feedback is one of the key pedagogical approaches that is claimed to enable gains in student achievement (Black et al., 2002; Black & Wiliam, 1998a; Black & Wiliam, 1998b; Hattie & Timperley, 2007). Ramaprasad (1983) and Sadler (1989, 1998), discuss the benefits of feedback on performance from a theoretical perspective. However, Black et al. (2002), Black and Wiliam (1998a, 1998b) and

Wiliam (2011) describe research studies in which students have measured learning gains in terms of improved test score performance, be that with external or internal assessments. Nonetheless, analysis of these studies shows that the reported outcomes are in the main claimed generically across formative practices and not specifically linked to feedback, and when feedback is mentioned, it is with regards to written approaches and not oral.

Orsmond et al. (2011) claim that despite the importance of feedback, it has historically received less attention than assessment and it has only been over approximately the last ten years that a substantial amount of research into the pedagogy of feedback has been undertaken. Nevertheless, Hargreaves (2013) argues that despite six recent mega-reviews about feedback (Hattie & Timperley, 2007; Kluger & DeNisi, 1996; Mason & Bruning, 2001; Mory, 2004; Narciss & Huth, 2004; Shute, 2007), "we still lack many details about how feedback helps students' classroom learning" (p. 229-230), a view expressed more recently by Murtagh (2014) who contested that, notwithstanding the national and international significance afforded to feedback, including the assumption that it is beneficial to learning when utilised as a mechanism during formative assessment, the research in the field is somewhat scant.

The majority of investigations carried out in the field have explored the characteristics and impacts of written feedback (Dann, 2015b), with few studies involving oral feedback in secondary classrooms and even fewer in science. The reason that Dann (2015b) cites for the disproportionate levels of analysis is because written feedback is more tangible in nature and subsequently more easily analysed. Dann (2015b) also discusses the lack of status ascribed to spoken language in UK schools, citing Michael Gove, the then Minister for Education as saying "you aren't learning anything when you're talking" (2013). Alexander (2014) argues that in British classrooms there is a proclivity for written work to be seen as 'real' work, with oral interactions that occur not as highly valued and seen as a prelude to, rather than a form of, learning.

Not only is the existing evidence focused on written feedback, it has largely been undertaken within the fields of higher education or English as a Foreign Language (EFL), according to the review conducted by Elliott et al. (2016), with a prevalence of feedback literature associated with students' perspectives relating to computer generated feedback (Hebert & Vorauer, 2002; Mason & Bruning, 2001; Narciss, & Huth 2004), and higher education settings (Blair & McGinty, 2012;

Buckley, 2012; Ferguson, 2011). The notion of feedback as a process undertaken between the teacher and the student as a mechanism for developing autonomy and learning has been examined by a number of studies. These have been conducted with medical students in higher education (Watling, Driessen, Van der Vleuten, Vanstone & Lingard, 2012), and children of primary age (Hargreaves, 2011, 2013; Murtagh, 2014). None of the studies examined students' within secondary science classrooms, the focus of this study.

In conducting their meta-analysis of the effects of feedback interventions on performance, Kluger and DeNisi (1996) defined a range of criteria for assisting them in identifying which studies to examine. They focused on quantitative studies that: only examined feedback interventions; used control groups; measured performance. From the original 3000 studies they identified, they focused on only 131 that they considered robust enough for consideration. Kluger and DeNisi (1996) argue that the some of the early experiments in the field suffered from major problems including: (1) Inaccurate operationalisations of knowledge of results – as some researchers appeared confused as to the what knowledge of results meant and consequently manipulated and reported effects from inappropriate variables. (2) Poor methodology – including studies of numbers of four participants or fewer, with experimenters serving as participants; furthermore, most did not have proper experimental controls and although some authors recognised these problems none considered them a threat to their conclusions. (3) A lack of attention to inconsistent results – inconsistencies in the beneficial effect of knowledge of results on performance were frequent but often ignored. For example, Kluger and DeNisi (1996) cite work carried out by Judd (1905) who found that knowledge of results actually increased performance errors (at least immediately following the manipulation), and yet Judd concluded categorically that knowledge of results improved performance.

Hargreaves (2013) argues that many earlier studies reviewing feedback practices were conducted in experimental conditions rather than through the observations of what occurs in classrooms. Such studies may provide insights into potential benefits for learning, however, as they are experimental by design and evaluating strictly defined interventions, less is known about feedback practices occurring in naturalistic authentic settings. The focus therefore, of some of the literature associated with feedback is too narrow in scope, as studies are not conducted in classrooms examining the teaching process (Svanes & Skagen, 2016). If it is to become more useful for practitioners, policy makers, and

researchers, rather than focusing feedback research on empirical studies ascertaining the content and form of feedback, it may be beneficial to focus on “the chain of events leading from feedback to successful learning” (Hargreaves, 2011, p. 121), studied within authentic classroom contexts as part of the teaching process (Svanes & Skagen, 2016). Alongside this, feedback studies will be more effective if they link students’ learning to teachers’ teaching repertoires (Svanes & Skagen, 2016; Vercauteren, 2009) and are situated within a theoretical framework that “places greater attention on the cognitive processes that are involved in learning and on the social situation within which feedback is given and received” (Wiliam, 2018, p.1).

Consequently, this study aims to investigate science teachers and students *in situ,* with feedback analysed in authentic science classrooms as part of the teaching process, in order to provide more useful ideas for practitioners and policy makers (Svanes & Skagen, 2016). The next section examines relevant studies to identify what perceptions have been identified previously, and highlight where research opportunities in the field exist, therefore situating the aim and research questions explored by this study.

2.10.1 Analysis of Teachers’ and Students’ Perceptions of Feedback

Research findings across apposite studies examining a variety of aspects associated with feedback and feedback practices undertaken in chronological order since the analysis conducted by Tunstall and Gipps (1996) can be seen in Appendix 1. The studies identified are associated with enquiries examining feedback within a school context, including, where possible, those linked with science teaching. These studies were reviewed as the research focused on oral feedback and/or written feedback, or feedback in general. Many studies were conducted in primary settings (Dann, 2015a; Gipps et al., 2000; Hargreaves, 2011, 2012, 2013, 2014; Knight, 2003; Murtagh, 2014; Ruiz-Primo & Li, 2013; Vercauteren, 2009), whilst the rest explored feedback in secondary classrooms outside the UK (Chin, 2006; Gamlem & Munthe, 2014; Gamlem & Smith, 2013; Nadeem, 2015; Peterson & Irving, 2008; Plank, Dixon & Ward, 2014; Voerman et al., 2012; Williams, 2010), apart from Weeden and Winter (1999) who interviewed students in England from across both primary and secondary phases. This analysis indicates how very few studies were conducted in the UK, with none identified investigating oral feedback within secondary science classrooms. A more detailed critique of the methodological approaches of apposite studies relevant to this research study will be conducted in Chapter 3.

In order to ascertain which aspects of oral feedback are perceived to benefit learners, evidence will be gathered and analysed from the perspectives of both teachers and students. The ability of students to conceptualise and articulate learning strategies and processes that are beneficial to their learning is well documented, with researchers claiming that even very young children are able to verbalise issues thoughtfully, honestly and articulately (Gipps et al., 2000; McCallum, Hargreaves & Gipps, 2000; Murtagh, 2014; Weeden & Winter, 1999; Williams, 2010), and consequently inclusion of students' perceptions is an "important element in furthering our understanding of teaching and learning" (McCallum et al., 2000, p. 275). The Organisation for Economic Cooperation and Development (OECD) (2016), who conduct international studies utilising students' responses, argue that students are a reliable source of information because even though they may not recall exactly what happens in science classrooms they are more likely to report what occurs, whereas teachers are liable to inflate responses as they wish to be positively viewed by others.

Findings across these pertinent studies highlight that teachers' perceive feedback as helpful to learning (Gipps et al., 2000; Hargreaves, 2011), even though teachers were unclear what constituted feedback (Knight, 2003), with no one agreed definition existing across these studies, if indeed it was defined at all. Common definitions across those studies that did define feedback, ranged from feedback associated with 'closing the gap' (Dann, 2015a; Vercauteren, 2009; Weeden & Winter, 1999), to feedback as useful information obtained from various sources related to performance or understanding (Gamlem & Munthe, 2014; Gamlem & Smith, 2013; Voerman et al., 2012), and feedback as all comments or actions undertaken by the teacher as a reaction to any activity or behaviour of students, including during IRF exchanges (Chin, 2006; Hargreaves, 2014; Ruiz-Primo & Li, 2013). Consequently, some of the aspects postulated as feedback in the studies examined do not correspond with those that have been theorised by this study. This does not limit the conceptualisation; rather it represents it as one hypothesis within the continuum of ideas present in the field. As Knight (2003) argues, feedback definitions appear to lie along a continuum, from a broad view at one end to a narrower one at the other (Peterson & Irving, 2008). Knight (2003) describes this feedback continuum consisting of:

> *At one end, Askew and Lodge (2000) claiming feedback is almost everything that happens in a classroom. At the other end, Ramaprasad's (1983) definition, modified by Sadler in 1989 for educational purposes, focuses*

> *quite specifically on an improvement model; that of closing the gap between desired and actual performance. Tunstall and Gipps' (1996) notion of feedback appears to fit somewhere in the middle as it encompasses both negative and positive feedback as well as evaluative and descriptive feedback. (p. 16)*

Notwithstanding the variety of interpretations of feedback within the field, all studies (Appendix 1) were included, in order to ensure that a detailed analysis was conducted of previous research exploring classroom feedback, especially with regards to teachers' and students' perspectives. From the analysis of research studies that have investigated feedback practices in schools (see Appendix 1), very few explore feedback practices from both teachers' and students' perspectives. However, in some cases (Chin, 2006; Gamlem & Munthe, 2014; Ruiz-Primo & Li, 2013) teachers' practices were investigated as stand-alone phenomena in isolation of any perspectives. Alongside the limited use of participant viewpoints, findings from the investigations examined have more often analysed the types of, or amounts of, feedback provided, rather than eliciting characteristics of feedback and feedback practices perceived to help students' learning, with a number of studies using Tunstall and Gipp's (1996) typology (Dann, 2015a; Murtagh, 2014; Ruiz-Primo & Li, 2013; Vercauteren, 2009).

Some of the characteristics related to the content and form of feedback that the teachers in the examined studies perceived were beneficial to students' learning, align to the conceptualisation of feedback theorised in this study, including: (1) The focus is associated with learning such as, *discrepancy*, *progress* and success criteria interactions (Gipps et al., 2000; Hargreaves, 2011; Weeden & Winter, 1999). (2) Feedback being provided in a form that is accessible to learners (Hargreaves, 2011; Nadeem, 2015). (3) The timing of oral feedback, especially its immediacy, is helpful for students (Gipps et al., 2000; Hargreaves, 2011; Weeden & Winter, 1999). (4) Limited evidence of feedback being provided related to learning (Gamlem & Munthe, 2014; Voerman et al., 2012). However, in contrast and worth noting from the studies analysed, are characteristics from teachers' perceptions, which are contrary to the conceptualisation of feedback, set forth by this study. These include feedback as praise (Gipps et al., 2000; Knight, 2003) and questioning as instruction and not feedback (Knight, 2003; Voerman et al., 2012). Whether or not these are perceived as beneficial by students, and therefore expand the conceptualisation of feedback theorised by this study, will be considered in later chapters when pertinent data are analysed.

However, there are additional aspects of the feedback process related to social and personal factors, “in particular the need for students to value the feedback given and play an active role in constructing it” (Hargreaves, 2011, p. 126) that maybe more supportive to learning. A model drawn upon to analyse teacher practices was Torrance and Pryor’s (2001) convergent and divergent ideal typical approaches (Dann, 2015a; Hargreaves, 2011, 2012, 2013, 2014). Analysis of the previous research identifies aspects germane to this investigation regarding such teachers’ feedback practices, including: the dominance of convergent evaluative interactions, especially with oral interactions (Chin, 2006; Gamlem & Munthe, 2014; Knight, 2003; Murtagh, 2014; Ruiz-Primo & Li, 2013; Vercauteren, 2009); the locus of responsibility shifting during feedback, including during oral interactions, with teachers being either directive and students passive, to teachers supporting proactive participation from both parties (Gipps et al., 2000; Hargreaves, 2011, 2013; Murtagh, 2014; Voerman et al., 2012); and the use of feedback to provoke learners to think more critically (Hargreaves, 2011), including the use of open questions in oral interactions to facilitate productive reasoning in students (Chin, 2006). These findings will be of importance when oral interactions that occur within the classrooms of the teachers’ in this study are analysed.

The exploration shows that teachers in the studies perceive feedback to be beneficial to learning, aligning their views to the research stated benefits of divergent descriptive feedback (Gipps et al., 2000; Hargreaves, 2011; Knight, 2003). However, in some studies this perception is in juxtaposition to the practices observed from the teachers, including their use of oral feedback (Chin, 2006; Gamlem & Munthe, 2014; Knight, 2003; Murtagh, 2014; Ruiz-Primo & Li, 2013; Vercauteren, 2009). This in part could be due to teachers not being clear as to what constitutes feedback or how to use it effectively (Knight, 2003). Sadler (1989) also suggests teachers’ ineffective use of feedback may be because it is more difficult for them to comment on learning which is “continuous rather than lockstep” (p.123). He argues this may be because it is easier to provide judgements in terms of facts memorised, concepts acquired or content mastered, than it is to think in terms of the quality of a student’s response or degree of expertise, as this necessitates teachers having the tacit knowledge required to be able to provide such feedback.

From the analysis of apposite studies, it can be seen that students were able to comment on their own learning (Gipps et al., 2000; Murtagh, 2014; Williams, 2010, Weeden & Winter, 1999), and from their perspectives the synthesis indicates that, for students, feedback is most helpful for their learning when it: (1) Increases

students' autonomy and ownership of their learning drawing on divergent practices (Hargreaves, 2012, 2013, 2014; Murtagh, 2014). (2) Occurs as a dialogue between students and teachers (Dann, 2015a; Hargreaves, 2011, 2012, 2013, 2014; Plank, Dixon & Ward, 2014; Weeden & Winter, 1999) or between themselves and their peers (Gamlem & Smith, 2013; Plank, Dixon & Ward, 2014), with students' preference being that such interactions occur during the learning as they can be more individualised (Hargreaves, 2013; Murtagh, 2014; Weeden & Winter, 1999; Williams, 2010). (3) Provides ideas of how to improve – *discrepancy* feedback (Dann, 2015a; Gamlem & Smith, 2013; Hargreaves, 2011; Murtagh, 2014; Peterson & Irving, 2008; Weeden & Winter, 1999; Vercauteren, 2009; Williams, 2010). (4) Indicates what has been done well – *progress* feedback, although this is not mentioned as often as *discrepancy* feedback (Hargreaves, 2011; Vercauteren, 2009; Williams, 2010). All of these are features attributed to effective learning and/or divergent approaches to the utilisation of feedback and aligned to constructivist theories, and students signify some preference for oral feedback (Weeden & Winter, 1999; Weeden, Winter & Broadfoot, 2002; Williams, 2010).

Examination of students' perspectives from the studies also indicates that learners are not always aware of which success criteria are being aimed for, and consequently what quality would look like with regards to learning goals (Vercauteren, 2009). Indeed, Hargreaves (2011), argues that reference to learning objectives within feedback needs to be further analysed, as the use of such criteria can "actually take over from learning rather than encourage it" (p. 126). This may occur if objectives are used in a convergent way and dominate the learning experience, with criteria compliance and criterion attainment replacing learning (Torrance, 2007). As such, divergent approaches to the use of objectives " may involve negotiating with and among students as to what the criteria should be" (Pryor & Crossouard, 2008, p. 16), linked to goals they value (Butler & Winne, 1995; Hargreaves 2011), and be the fertile ground for students' learning (Hargreaves, 2011), thus helping them to improve (Torrance, 2007). This may be the reason why several of the studies discussed the lack of alignment between teachers' and students' understanding regarding the feedback provided, with evidence that "much feedback was either unfocused or of little use in improving work" (Weeden & Winter, p. 12), leaving students confused (Dann, 2015a; Murtagh, 2014; Vercauteren, 2009; Weeden & Winter, 1999). "The variability of feedback reported by students and their sometimes confused perceptions of its intention, supports Sadler's (1998) view that

it is the quality, not just the quantity of feedback that merits our closest attention" (Weeden & Winter, 1999, p.10).

An additional study of interest was conducted by Carless (2006), who investigated university tutors and students' perceptions of written feedback provided on assignments. Carless (2006) noted that when establishing the different perceptions of students and tutors in terms of feedback, tutors: (1) believe that they are providing more detailed feedback than the students believe they receive and (2) perceive their feedback to be more useful than students consider it to be. Parenthetically, Carless (2006) does not offer reasons as to the discrepancies between students' and tutors' perspectives. However, a consequence of a lack of alignment between tutor and student is that the student may pay selective attention to the parts of the tutor feedback that they consider, often erroneously, to be the most relevant (Orsmond et al., (2011). Nonetheless, what is of interest for this study is that the views of university students' concurred with those from the studies analysed within a school environment, and demonstrated that from their perspective, the feedback that students perceived to be useful included pertinent comments regarding *discrepancy* discussions of how they should improve in the future (Carless, 2006; Dann, 2015a; Hargreaves, 2011; Peterson & Irving, 2008; Williams, 2010). All of these perceptions relating to students' views of feedback and learning will be of interest when considering the reflections obtained from students within this study.

Throughout the literature reviewed, the assumed importance of feedback as part of the process of learning has been highlighted, as well as the paucity of studies conducted analysing teachers' practice, alongside both teachers' and students' perceptions related to how it can help learners in secondary science classrooms. This, it is reasoned, is justification for concentrating on oral feedback as the area to investigate for this study, and drawing on an interpretivist epistemology, to develop insights into aspects of practices in science teachers' classrooms. Therefore, in order to contribute to thinking and knowledge associated with oral feedback; there is a need and justification for the aim and research questions associated with this study to be addressed.

2.11 Chapter Summary

In summary this chapter has conducted a cross-sectional synopsis of the literature allied to learning, and in particular students' learning in science, and learning theories relevant to science. It has established the cogency of feedback as

a pedagogical approach that has the potential to promote learning. Two ideal typical approaches, convergent and divergent (Torrance & Pryor, 2001), have been used throughout to frame opposing implementations of feedback affiliated with contrasting constructivist and behaviourist views of learning within classrooms.

Different dimensions, including feedback conditions and foci associated with its effective utilisation have been presented, such as: Ramaprasad's (1983) three conditions (subsequently developed by Sadler (1989)); Hattie and Timperley's (2007) three questions; Tunstall and Gipp's (1996) typology; Kluger and DeNisi's (1996) possible responses to feedback; Kluger and DeNisi (1996) and Hattie and Timperley's (2007) assimilated hierarchical levels of foci. Two models for feedback were also presented linked to the conditions analysed; namely, *discrepancy* and *progress* feedback.

The importance of both teachers and students as active co-owners of the feedback process has been examined. The teacher's role within feedback has been presented as requiring them to provide feedback accessible to the student (be that the complexity or timeliness of it in order that it supports learning), or to promote student-directed learning (through cognitive engagement, nurturing students' autonomous capabilities or the use of open questions). The students' role entails them operating as *dynamic* co-agents in the process, cognitively engaged, active and involved in generating evaluative information and ideas for what to do next. Nonetheless, a diametrically opposed process, in which students are *passive* recipients of teacher judgements, has been contested can also occur. As such, arguments have been proposed for the discrepancies between the way that teachers may perceive and implement feedback linked to their different conceptualisations of learning, affiliated to the convergent and divergent ideal typical approaches of Torrance and Pryor (2001), and the roles affected by both teachers and students.

Relevant enquiries were examined to identify teachers' feedback practices along with educators' and students' perceptions of feedback, in order to provide a backdrop against which the findings of this study will be analysed and compared. Previous studies examining teachers' feedback practices, including oral feedback, identified a number of pertinent aspects, namely: the dominance of convergent evaluative interactions (Chin, 2006; Gamlem & Munthe, 2014; Knight, 2003; Murtagh, 2014; Ruiz-Primo & Li, 2013; Vercauteren, 2009); limited evidence of feedback being provided related to learning (Gamlem & Munthe, 2014; Voerman et

al., 2012); the locus of responsibility shifting during feedback (Gipps et al., 2000; Murtagh, 2014); and the use of open questions (Chin, 2006).

The exploration of apposite studies indicated that teachers perceive feedback to be beneficial to learning (Gipps et al., 2000; Knight, 2003), with advantageous characteristics identified as: (1) a focus associated with learning such as, *discrepancy*, *progress* and success criteria interactions (Gipps et al., 2000; Hargreaves, 2011). (2) Feedback being provided in a form that is accessible to the learner (Hargreaves, 2011; Nadeem, 2015). (3) The immediacy of oral feedback in particular (Gipps et al., 2000). Nevertheless, teachers' perceptions and practices were shown to be in juxtaposition (Chin, 2006; Gamlem & Munthe, 2014; Knight, 2003; Murtagh, 2014; Ruiz-Primo & Li, 2013; Vercauteren, 2009), with a dominance of convergent evaluative teacher practices evidenced (Chin, 2006; Gamlem & Munthe, 2014; Knight, 2003; Murtagh, 2014; Ruiz-Primo & Li, 2013; Vercauteren, 2009).

Students' perceptions identified from germane studies indicated feedback is most helpful for their learning when it: (1) Increases their autonomy and ownership of their learning (Hargreaves, 2012, 2013, 2014; Murtagh, 2014). (2) Occurs as a dialogue between themselves, their teachers and/or peers (Dann, 2015a; Gamlem & Smith, 2013; Hargreaves, 2012, 2013, 2014; Plank, Dixon & Ward, 2014). (3) Provides ideas of how to improve – *discrepancy* feedback (Carless, 2006; Dann, 2015a; Peterson & Irving, 2008; Williams, 2010). (4) Indicates what has been done well – *progress* feedback, although this is not mentioned as often as *discrepancy* feedback (Williams, 2010). The examination of students' perceptions also indicated their uncertainty with regards to learning goals, and success associated with them (Vercauteren, 2009), along with a preference towards oral feedback (Williams, 2010).

Finally, the analysis conducted in this chapter has constructed a theoretical conceptualisation of feedback, which states that feedback is:

> ***Useful information provided from an agent (teacher, peer, book, parent, self or personal experience) which supports learning, relates to learning goals, regarding aspects of one's performance or understanding, and is utilised to improve one's learning of science.***

Justification was finally provided from the literature as to feedback being a legitimate area of focus due to the limited knowledge regarding beneficial feedback practices that support learning, and a lack of studies investigating oral feedback in authentic secondary science classrooms. Consequently, this research study aims to explore the nature of science classroom oral feedback interactions that are undertaken between teachers and their students and which are perceived to promote learning. Therefore the main area of interest is:

How science teachers conceptualise and practise oral feedback, and how students perceive it helps their learning.

Based within the field, the aim of the study is to answer the following research questions.

1. *How do science teachers conceptualise feedback and perceive their feedback practices including oral feedback?*
2. *What characteristics of oral feedback do science teachers perceive as improving learning?*
3. *What types of oral interactions do students perceive as helping learning?*
4. *To what extent and in what ways do science teachers' oral interactions compare to their conceptualisation of oral feedback and students' perceptions of what helps learning?*

The next chapter will explore the methodological framework employed, in order that the aims and research questions of this study can be addressed, drawing on the methods of apposite studies and the research literature to justify the approach taken.

Chapter 3 Methodology

3.1 Research Focus

The purpose of this research is to ascertain '*How science teachers conceptualise and practise oral feedback, and how students perceive it helps their learning*'. In order to address this aim and answer the research questions, ten case studies of secondary school science teachers were conducted within one academic year, drawing on the principles and methods of qualitative case study research design. Subsequently, grounded theory was utilised to analyse the data in order to generate theory and add to the knowledge in the field. This chapter describes, explains and justifies the methodological framework that was undertaken.

The oral interactions that occurred within science classrooms between teachers and their students were investigated in light of views from both the teachers and the students. Firstly, this chapter outlines the research design in light of the ontological and epistemological standpoints taken. The chapter then outlines the contexts and selection of case study participants. Subsequently, the strengths and weaknesses of each data collection method will be explored. How the analysis was conducted is described, and limitations of the study are considered, along with deliberations regarding the trustworthiness of the data. Finally, ethical matters relevant to this study are outlined.

In order to set in context the methodological framework implemented in this study, the research questions for this study are presented below:

3.1.1 Research Questions

1. *How do science teachers conceptualise feedback and perceive their feedback practices including oral feedback?*
2. *What characteristics of oral feedback do science teachers perceive as improving learning?*
3. *What types of oral interactions do students perceive as helping learning?*
4. *To what extent and in what ways do science teachers' oral interactions compare to their conceptualisation of oral feedback and students' perceptions of what helps learning?*

3.2 Research Methodology

The literature review was used to derive a theoretical definition for feedback as:

> ***Useful information provided from an agent (teacher, peer, book, parent, self or personal experience) which supports learning, relates to learning goals, regarding aspects of one's performance or understanding, and is utilised to improve one's learning of science.***

Exploration of apposite studies brought to light a lack of research into oral feedback within secondary science classrooms in the UK, with none in such contexts investigating feedback practices from both teachers' and students' perspectives. This research design was informed by the literature review as the study aimed to construct knowledge as a consequence of interpreting social settings in science classrooms. Accordingly, an inductive approach, in which theory is an outcome of the research, was undertaken (Bryman, 2012), in order to draw out generalisable inferences from the observations (Bryman, 2012). However, it is due to there being the possibility of limitations of myself as the researcher that Lincoln and Guba (1985) have proposed this as one reason for replacing the concern for generalisability from any findings with that of transferability. Generalisability, by definition, refers to the ability of extending the trustworthiness of one's case study findings to other cases of the kind (Moriceau, 2014), whereas transferability is showing that the findings have applicability in other contexts (Lincoln & Guba, 1985). Therefore, this study will further develop understanding and contribute to theories regarding oral feedback by indicating findings applicable and transferable to other contexts.

3.2.1 Philosophical Underpinnings

In an attempt to understand the relationship between evidence and knowledge of how feedback was conceived, used and perceived, constructivist and interpretivist ontological and epistemological standpoints were adopted by this study. This allowed theories pertaining to oral feedback practices of the teachers that the students perceived to be beneficial for their learning to be developed from the data.

Social science research is concerned with philosophical questions relating to the nature of knowledge and truth (epistemology) and being (ontology), which underpin human judgements and activities (Somekh & Lewin, 2011). These questions focus on people – individuals and groups – and their behaviour within cultures and organisations that vary widely socially and historically (Somekh & Lewin, 2011). As this research study answers questions that relate to human activities and behaviours, a social science research methodology was used to govern the design as well as the choice and use of particular methods.

Edirisingha (2012) defines ontology as the nature of reality. Assumptions of an ontological kind – assumptions which concern the very nature or essence of the social phenomena being investigated – are either external to individuals or are a product of individual consciousness (Cohen, Manion & Morrison, 2008). Throughout literature, ontological assumptions are referred to in terms of their positioning. These positions are frequently referred to respectively as objectivism (external to individual) or constructivism (being constructed by social actors) (Bryman, 2012). Constructivism has also come to include the notion that researchers' own accounts of the social world are constructions and as such, the researcher always presents a specific version of social reality, rather than one that can be regarded as definitive (Bryman, 2012). As the purpose of this research was to construct theory through the interpretation of data, the ontological position undertaken by the study was constructivism.

Whilst discussing the interpretivist epistemological orientation, Bryman (2012) argues that social and natural sciences are fundamentally different, because social reality has a meaning for human beings and therefore human action is meaningful: i.e. they will act on the basis of the meanings they attribute to their acts and the acts of others (Bryman, 2012). Understanding the meaning, for participants in the study, of the events, situations, and actions with which they are involved, and of the accounts that they give of their lives and experiences, is central to what is known as the "interpretive" approach to social science (Maxwell, 2009). It is therefore the job of myself as the social scientist to gain access to the thinking of those involved in the research and interpret their actions and their social world from their point of view (Bryman, 2012). Therefore, the central endeavour of interpretivism is to understand the subjective world of human experience through a concern for the individual and by understanding them from within (Cohen et al., 2008). This occurs through a focus on action, where theory is emergent and grounded in the data generated and should not precede research but follow it

(Cohen et al., 2008). This approach to research was undertaken in order to understand the underlying meaning of events and activities. Therefore, in terms of this study, a key undertaking was determining the 'thinking' of the participants in respect to their conceptualisation of oral feedback.

Hudson and Ozanne (1988) describe the need for the interpretivist researcher to enter the field with some sort of prior insight into the research context. However, he or she must remain open to new knowledge throughout the study and let it develop with the help of informants (Edirisingha, 2012). By taking an ontological position of constructivism and the epistemological orientation of interpretivism, I needed to be conscious that my research of the phenomenon existed only through my mental appreciation and analysis of it. There was the potential in the methodological approach for bias and undue influence from my interpretations and position as the researcher; this was acknowledged and mitigated, and Section 3.8 will discuss how this was achieved for this study. The research design employed is discussed in more detail in the next section of this chapter.

3.3 Research Design

Two research traditions exist linked to apparently opposed epistemological extremes, each with associated methodological issues: quantitative (emphasising quantification in the collection and analysis of data) and qualitative (emphasising words rather than quantification in the collection and analysis of data) (Bryman, 2012; Snyder, 1995). Gillham (2010) distinguishes between these two different methods of enquiry (quantitative and qualitative research) as "natural-sciences style" and "naturalistic" research respectfully (p. 5). Unlike the deductive model that uses a predetermined procedure of investigation, researchers wishing to make sense of what they find after they have found it draw on an emergent design along with inductive theorising (Gillham, 2010). The major distinction is that the inductive researcher is investigating phenomenological meaning and concerned with the qualitative, contextual element of the enquiry (Gillham, 2010; Snyder, 1995); that is, they wish to examine how people understand themselves or their setting in order to identify the underlying reasons in people's feelings, perceptions or experiences.

Notwithstanding, this study's aims are to explore aspects of how science teachers practise oral feedback and to answer research questions related to authentic secondary science classrooms. It has been acknowledged that analysis in such environments encompasses many challenges for researchers, with no method (or methodology) devised so far without limitations (Mercer, 2010). Consequently,

the combined use of quantitative and qualitative methods has become more common in educational research (Mercer, 2010). The status of the separation between the two research traditions can be ambiguous, with some in the field regarding the distinction as a fundamental contrast, whilst others see it as no longer helpful, simply false or less about mutual exclusivity and more about them being inextricably linked (Bryman, 2012; Snyder, 1995). However, as a means of classifying different methods of social research and considering issues concerned with its practice, the distinction still holds currency (Bryman, 2012).

Nevertheless, Mercer (2010) contends that arguments suggesting that only qualitative research can deal with the human reality of school life remain unconvincing. Even though qualitative and quantitative research have their distinctive strengths and weaknesses, the important question to consider is "What do I need to do to answer my research questions?" (Mercer, 2010, p. 10). Consideration of this question by an open-minded researcher will lead to appropriate methods and data analysis procedures being used, regardless of the epistemological or ontological associations. As such, an effective enquiry examining talk can be designed to draw on two or more methods for analysing data in a complementary way (Mercer, 2010).

However, as the researcher, I needed to note that "different methods may embody different conceptions of the nature of talk" (Mercer, 2010, p. 9), with each type of approach having its own virtues. Nevertheless, the integrity of the research enterprise need not involve making an ideological commitment to either research tradition, as both have value under certain conditions, and researchers often combine both qualitative and quantitative procedures (Mercer, 2010; Snyder, 1995). Therefore, to ensure a successful combination of research methods and data analysis, as the researcher, a "flexible, sensitive theoretical framework" (Snyder, 1995, p. 45) is required, if understanding the complexity of real-life events is to be achieved (Mercer, 2010; Snyder, 1995). Consequently, for this study, the choice of an inductive interpretivist position emerged logically from the standpoints outlined, with a mixed methods approach utilised to gather and analyse data in order to be able to answer the research questions.

Due to the subjective nature of qualitative research, as a naturalistic researcher I needed to be aware of what others have done (Gillham, 2010). However, existing literature may have little bearing upon my investigation, as previous findings may not be relevant, due to primary inclusion criteria for this study being examining classrooms of participants who teach science in outstanding secondary schools in the UK, drawing on both teachers' and students' perspectives.

Consequently, in order to justify the research design and associated methods, it was decided to analyse the apposite enquiries that have been reported in the literature i.e. studies that had investigated feedback in schools examining teachers' practices and/or students' perspectives. These relevant research studies were analysed in order to ascertain common methodologies and methods, along with strengths and limitations in order to influence the approaches adopted by this study. Relevant aspects of the synthesis of these studies are explored in the next sections of this chapter.

3.3.1 Researching Authentic Classroom Practice

As this study is looking to answer research questions drawing on multiple perspectives, studies that explored the viewpoints of both teachers and students in authentic classrooms, were examined to understand the ways in which others had researched the field, in order to appropriately "review the context from which the research questions, the means to investigate them and likely explanations will emerge" (Gillham, 2010, p. 6). Many of these studies are the same as those examined in Chapter 2 (see Appendix 1). Inclusion criteria for publications in the analysis were if the studies examined teachers' classroom feedback practices (see Appendix 2), and/or those which explored secondary aged students' perspectives of feedback (see Appendix 3).

In order to inform the design of this research a coding system was employed to compare and contrast the different research methods employed across the eligible studies. From this analysis it can be seen that the utilisation of different methods was not uniform, even for studies employing the same research approach, with different authors examining classrooms in a variety of ways. Several methods currently exist for examining classroom feedback, with the most popular used by researchers across the studies being: (1) interviews accompanied more often with transcript analysis (Carnell, 2000; Gamlem & Smith, 2013; Hargreaves, 2012, 2013, 2014; Knight, 2003; Murtagh, 2014; Nadeem, 2015; Dawes & Staarman, 2009; Peterson & Irving, 2008; Plank, Dixon & Ward, 2014; Vercauteren, 2009; Williams, 2010). (2) Technological recordings (Chin, 2006; Gamlem & Smith, 2013; Peterson & Irving, 2008; Vercauteren, 2009), with transcripts subsequently produced, although this was not always the case (Gamlem & Munthe, 2014; Hargreaves, 2012, 2013, 2014; Nadeem, 2015; Voerman et al., 2012). In addition to these main methods a number of the researchers also used: (3) observations and/or field notes (Gamlem & Smith, 2013; Hargreaves, 2012, 2013, 2014; Knight, 2000; Murtagh, 2014), (4) analytical frameworks (Gamlem & Munthe, 2014; Voerman et al., 2012),

and (5) students' work (Murtagh, 2014; Nadeem, 2015). Reducing the number of different sources of evidence may affect the trustworthiness of any findings claimed (Gillham, 2010), and for some of the studies examined their assertions are limited as a consequence of the lack of different evidences collected and analysed. For example, many did not include any interview evidence as part of their analysis (Chin, 2006; Gamlem & Munthe, 2014; Voerman et al., 2012), even though for all of these studies an additional perspective could have added further insights into the research questions being addressed. Indeed, some studies did not capture or analyse all of the interactions that occurred between the teacher and the students (Chin, 2006; Voerman et al., 2012), potentially limiting findings from the studies. Alongside the limited evidence collected by some of the studies, a further limitation is that many only gathered data from one perspective: either the teachers' or the students'. It is important to include both the teachers' and the students' perspectives in order to gain richer insights into perceptions of the classroom and to increase the trustworthiness and transferability of any findings (Lincoln & Guba, 1985). Therefore, to increase the trustworthiness of the findings of this study, all of the methods identified were initially used, with only students' work not being utilised throughout the data collection period, as initial analysis highlighted it was not capturing data that addressed the research questions.

It is worth noting from the synthesis of these relevant studies that only one analyses perspectives from both teachers and students alongside classroom observations (Murtagh, 2014), and this study was not examining oral feedback practices of teachers in science classrooms. This study adopted a case study methodological approach and drew on a wide range of sources of evidence (teacher and student interviews, observations and field notes, students' work). Even though the research aims are different to this study, the methodological approach is pertinent, as it looked to examine feedback and feedback practices in authentic primary literacy classrooms, using both teachers' and students' perspectives.

In the main studies that employed a different research design to case study, used focus groups that only ascertained students' perspectives (Carnell, 2000; Peterson & Irving, 2008; Plank, et al., 2014; Weeden & Winter, 1999; Williams, 2010), were looking either to measure a specific strategy (Nadeem, 2015), or to utilise a predetermined analytical tool (Gamlem & Munthe, 2014). As this study aims to illuminate teachers' classroom oral practices by adopting a constructivist epistemological approach, the analytical framework was constructed from the data, ensuring data were grounded in, and analysed drawing on multiple perspectives.

Case study was deemed the most appropriate research design to obtain the answers to the research questions, by seeking a range of different kinds of evidence from the case settings (Gillham, 2010). Further discussions regarding the strengths and weaknesses of these different sources of evidence will be discussed in the Section 3.6.

Alongside the points identified from this analysis that have influenced the design of this study, it is interesting to note the number of schools that were worked with: four out of the 13 studies, conducted the research in one school, a further five working across two schools, and four of the studies working in more than two schools. With regards to the number of teachers engaged in the studies, and the number of hours of evidence collected, they range from 13 hours (Voerman et al., 2012), up to 56 hours (Gamlem & Munthe, 2014). Studies with the focus of ascertaining students' perspectives drew on participant numbers ranging from nine to 56. These students were, in all but one of the studies, drawn from multiple classrooms. This study draws on case studies of ten participant science teachers, across two secondary schools in the UK, to reflect the diversity in practice of teachers, in different classrooms. Implications from this analysis in terms of the context and selection of participants engaged in this research study will be explored in Section 3.5.

3.3.2 Research Methodology: Case Study

Simons defines case study as

> *an in-depth exploration from multiple perspectives of the complexity and uniqueness of a particular project, policy, institution, programme or system in a 'real life' context. It is research-based, inclusive of different methods and is evidence-led. The primary purpose is to generate in-depth understanding of a specific topic.* (2009, p. 11)

This concurs with Gillham's (2010) definition, in which he argues that case study is utilised to investigate and answer specific research questions from within the case setting, by drawing on multiple sources of evidence in order to abstract and collate data to generate theories regarding what works best or makes sense. These two definitions of case study research therefore align with the aims of this study.

This examination will be undertaken within the real-life context of secondary schools, drawing on multiple lines of evidence to generate insights into oral feedback practices. As a lack of breadth and coverage is a key criticism levelled at case study research, with many researchers arguing that one of the limitations of case study is that it is difficult to generalise from one or a small number of cases (Bryman, 2012; Cohen et al., 2008; Simons, 2009; Somekh & Lewin, 2011). In order to mitigate this, a number of different aspects related to the trustworthiness of the study were considered, for example, collecting data from different sources, providing thick descriptions and contexts, and these will be explored in section 3.3.2.2.

In many cases, including this study, the aim is *particularisation*, which is defined as presenting a rich portrayal of a single setting to inform practice, to establish the value of the case and/or to add to knowledge of a specific topic, rather than generalisation for policy-making (Simons, 2009). Such thick descriptions provide others with a means to make naturalistic generalisations related to their own experiences and the possible transferability of findings to other milieu (Bryman, 2012; Somekh & Lewin, 2011). Therefore, through using case study methodology it is possible to develop a theory, which in turn can help researchers to understand other similar cases, phenomena or situations (Robson, 2002).

In summary, in order to answer the specific research questions and indicate which aspects of oral interactions that occur in science classrooms between the teacher and their students are perceived as supporting students' learning and are transferable to other contexts, the choice of a case study research design as a consequence of the ontological position and epistemological orientation already established for this study flows logically from the analysis conducted.

3.3.2.1 Defining the Case in this Research

Case study research is designed to illustrate general principles of an instance in action, providing a unique example of real people in real situations (Cohen et al., 2008). These real people and the cases they represent could include an individual, a clique, a class, a school or a community (Cohen et al., 2008). Through studying these real people in their real situations it is easier to understand ideas more clearly and how they fit together with abstract principles in order to answer specific research questions (Cohen et al., 2008; Gillham, 2010). The case involves a unit of human activity embedded and existing in the here and now of the

real world, and can only be studied or understood in context. As such it “merges in with its context so that precise boundaries are difficult to draw” (Gillham, 2010, p. 1).

The key consideration regarding establishing the case depends on the aim of the study and what you wish to find out (Gillham, 2010). Case study research asks the basic question ‘what is going on here?’ and therefore seeks to describe before trying to account for it (Somekh & Lewin, 2011). In this study, the cases investigated were the ten participant science teachers, as it was their oral practices that oral feedback had its origins and shaped experiences of students. This exploratory study was conducted by studying different teachers with a range of backgrounds (subject specialism, years of teaching experience, gender), to capture the complexities, obtain further in-depth information, and provide rounded, detailed illustrations of oral feedback in science classrooms. The social contexts were the science classrooms in which these teachers operated on a daily basis, with social interactions being between themselves and their students. The studying of the cases took place *in situ* by myself as the researcher, with multiple sources of evidence and perspectives collected in a timely manner to develop understanding, to enable the research questions to be answered and to address the aim of this study regarding oral feedback.

There are a number of different classifications of case study types that have been proposed by researchers. Yin (1984) identified case study types in terms of their outcomes: (1) Exploratory (as a pilot to other studies or research questions). (2) Descriptive (providing narrative accounts). (3) Explanatory (testing theories). Stake (1994 & 1995) and Yin (2009) between them distinguish a further seven case study types in terms of the reasons they are undertaken: (1) Intrinsic (a case that is unique or extreme to the researcher and of intrinsic interest is studied in order to understand the particular case in question). (2) Instrumental (a case is studied to gain insight or understanding into a particular issue or theory). (3) Collective (several cases are studied to gain a fuller picture of the issue or question). (4) Critical case (a well-developed theory exists and a case is chosen to allow a better understanding of circumstances when a hypothesis will and will not hold). (5) Exemplifying case (a case that captures the circumstances and conditions of an everyday or commonplace occurrence). (6) Revelatory case (a case providing research opportunities in hitherto inaccessible phenomena). (7) Longitudinal case (a case with two or more junctures investigated over time). Any case study design has the potential to include several of these different types depending on the research questions and their appropriateness in answering them (Bryman, 2012). The

present study is not dissimilar and covered the following case types: (a) Descriptive – as narrative accounts were produced for each of the teachers involved in the study. (b) Collective – an examination occurred across all ten teachers to develop a greater understanding regarding in class oral feedback practices. (c) Instrumental – as a greater understanding regarding a theoretically constructed definition of feedback was obtained from the ten teachers.

The dominant approach adopted during this study was instrumental case study, defined as "the study of a case (e.g. person, specific group, occupation, department, organisation) to provide insight into a particular issue" (Grandy, 2010, p. 474). Ten collective case studies were undertaken and an exploration of multiple instrumental case studies conducted, as science teachers' conceptualisations and practice with regards to feedback were compared across cases (Grandy, 2010).

A collective instrumental case study approach was taken to allow a deeper insight into oral feedback in science classrooms, so that the transferability of the case findings could be reported (Stake, 1995). The transferability was achieved by producing a thick descriptive account of the cases as a consequence of drawing upon multiple perceptions and sources of data. A thick description, i.e. rich accounts of the details of the culture, needs to take into consideration the circumstances, meanings, intentions, strategies, motivations, and so on, that characterise a particular episode, as well as being highly detailed in nature (Geertz, 1973). This is utilised to catch the diversity, variability, creativity, individuality, uniqueness and spontaneity of social interactions across the teachers (Geertz, 1973). Consequently, this case study produced a thick description by building a detailed and rich account of the teachers from multiple perspectives (theirs and their students), along with data collected from classroom recordings and field note observations. In conjunction with enabling transferability, it was important for this study to build a thick description to improve the trustworthiness of findings. Detailed considerations of such matters are discussed in the next section as well as 3.8.

3.3.2.2 Benefits and Limitations of Case Study Methodology

There are a range of benefits associated with case studies, with the main ones being that they are strong in reality and rich in data; they offer the capacity to understand unique features that may otherwise be lost; they produce results easily understood by a wide audience; and they can be undertaken by single researcher responding flexibly to changing situations over time (Cohen et al., 2008; Bryman, 2012; Simons, 2009). All of these benefits made it an ideal approach to undertake in

order to answer the research questions. In terms of working in schools, which by their very nature are difficult contexts to which to gain access, the benefit of the flexibility afforded to that of myself as the lone researcher meant that even though timings had to be adapted it was still possible to collect the data needed for the case study.

There are a number of limitations associated with case study research that needed to be considered. Limitations pertinent to this study included difficulties in: gaining access to teachers and classrooms, which is a major issue particularly for secondary schools; organising and processing data due to the large amounts generated; managing the analysis of the data; reporting findings concisely, including the issue that findings can be prone to observer bias (Berger, 2015; Bryman, 2012; Cohen et al., 2008; Simons, 2009). A further limitation of using case study relates to how the research is evaluated and the subsequent lack of transferability or generalisability that can be claimed, as it is not possible for a single case to yield findings that are representative to other cases (Bryman, 2012; Moriceau, 2014).

However, there are alternative ways that qualitative research can be evaluated, and one criterion that enables findings to be evaluated is trustworthiness. Where trustworthiness involves considering the credibility, transferability, dependability and confirmability of the study (Bryman, 2012; Lincoln & Guba, 1985). The characteristics and techniques employed so that this qualitative research achieved trustworthiness will be explored in more detail in section 3.8. Other techniques that were undertaken to counter limitations included establishing systems and procedures to catalogue data on an on-going basis, using a transparent coding schedule to concomitantly analyse all lesson recordings following the classroom data collection period; analysing the data comparatively throughout the study, and cross-checking the data through inter-rater approaches by another researcher.

In summary, through adopting an instrumental case study methodology, the study has developed from the data an understanding of feedback as a pedagogical approach. Furthermore, by establishing and using practices that mitigated for limitations associated with case study research, the findings are trustworthy and transferable.

3.4 The Pilot Phase

The purpose of the pilot phase was to ensure that the methods would allow me to answer the research questions, and to test the research methods and

instruments. It is always desirable to pilot research methods if at all possible, in order to refine the individual instruments used in the study (Bryman, 2012). However, this is not the sole use of piloting, it can also be carried out to ensure that the research instrument as a whole functions well (Bryman, 2012; Yin, 2009). The pilot case can specifically tighten the link between the research questions and the likely availability of evidence, and whether or not there needs to be any adaptations to the case study methods (Yin, 2009). A single case study was piloted, which afforded beneficial insights around the context and scale of the main study and the methods employed in order to provide sufficient trustworthy data that would answer the research questions posed. How this learning influenced the main phase of the study will be considered throughout the relevant sections in this chapter.

Due to the logistical challenges of collecting and analysing the pilot data, it was decided to focus on one school. A single teacher from the school was recruited, and as such only one teacher case study was carried out in the pilot phase. Abigail worked in an urban, mixed comprehensive 11-16 secondary school, which had approximately 800 students on role, and was rated 'good' by Ofsted at the time that the pilot case study was conducted. A total of eight lessons were observed over a six-week period. It is important for myself as the researcher to see participants in research as individuals engaged in a shared experience that they value (Simons, 2009). Such a perspective acknowledges that it is their experiences – their 'realities' – that will be documented and interpreted, and gives a strong message that I will be researching with them, not simply gathering data on or about them (Simons, 2009), and is a potential benefit of case study. This was of utmost importance for both the pilot and main study; in order to make the teacher feel at ease so that the data collected would represent their normal practices, meetings and discussions took place with all of the participants ahead of any data collection. As well as providing clarity about the research relationship, the meetings allowed teachers to ask questions and ethical and logistical issues were clarified, as it is important to be explicit about such aspects upfront (Simons, 2009).

For the pilot case study, the research methods were: (1) Audio recordings of all of the lessons using one audio recorder placed at the side of the classroom. (2) A structured observational schedule developed using guidance from Cohen et al. (2008) and drawing on the research of Dweck (2000) and Lemke (1990). (3) Field notes. (4) Photographs of students' work. (5) Copies of the teacher's lesson plan. (6) Student questionnaire. The pilot phase was helpful in evaluating the methods

and context of the study and influenced the main phase. As a consequence of the pilot study, a number of methods were no longer employed. These were:

- A structured observation schedule - the observation schedule was used to event sample and categorise every oral interaction that occurred between the teacher and the students. However, it became evident during the pilot phase that this did not allow every interaction to be captured, but only those that occurred when the teacher was addressing the whole class, and due to the complexity of the method other relevant data was not being recorded in the field notes.

- Photographs of students' work –this method afforded no useful evidence in relation to the research questions. This influenced the main study as student interviews were conducted instead, which retrieved richer and more relevant data.

- Copies of the teacher's lesson plan - the pilot teacher did not produce formal lesson plans: writing notes in a planner was the preferred method used. This method therefore provided no useful evidence in relation to the research questions.

- Student questionnaire - the data gathered from the questionnaire was limited and of little use in alluding to students' perspectives. This again influenced the main study and the utilisation of student interviews as a richer alternative data source.

The research methods used by the main study are explained and justified in Section 3.6 along with how they were influenced by the pilot phase.

3.5 Selection of Research Participants

The data collected from the pilot phase highlighted the importance of working within classrooms in which there were large amounts of teacher and student dialogue. Indeed, one of the limitations of Chin's study (2006) was that there were very few interactions that occurred that did not include the teacher addressing the whole class. However, one problem of selection is finding a site that provides the best location for the design (Cohen et al., 2008).

The school inspection framework in England regularly changes, and the framework at the time focused on the areas of: overall effectiveness; effectiveness of leadership and management; quality of teaching, learning and assessment;

personal development, behaviour and welfare; and outcomes for students (Ofsted, 2015). It was hoped that by identifying schools that had received an overall effectiveness grade of 'outstanding' then their classroom practices would be more likely to fall within the outstanding grade criterion for the quality of teaching, learning and assessment.

The grade descriptors used by inspectors to grade outstanding for the area of quality of teaching, learning and assessment include a number of statements that specifically mention feedback, both written and oral (see Table 3.1).

Outstanding (1)
Teachers provide students with incisive feedback, in line with the school's assessment policy, about what students can do to improve their knowledge, understanding and skills. The students use this feedback effectively. Students are eager to know how to improve their learning. They capitalise on opportunities to use feedback, written or oral, to improve.

Table 3.1 Relevant extract from Ofsted outstanding grade descriptors

Nonetheless, it is worth noting that even though the school may have received an overall effectiveness grade of outstanding, it cannot be assumed that all teachers within it were either at the school at the time of the inspection, or are operating at that level with regards to their teaching, learning and assessment practices. Indeed, teachers can have positive and beneficial impacts on their students' learning irrespective of any Ofsted grading. However, in terms of the study, its use as a criterion to identify the schools adds confidence to the selection process.

Ofsted no longer gives grades to individual teachers, and recommends that schools do the same when conducting internal observations. Therefore, it was not possible or deemed suitable to identify the Ofsted grading linked to either the science department or teachers within them. Any identification of teacher grading was deemed to be detrimental to the study due to the potential of harming the researcher and participant relationship. Getting off to a good start and maintaining positive relationships with the participants of the study is important in order to develop more intimate and informal relationships over times so that the data collected is representative (Cohen et al., 2008; Simons, 2009).

There were a number of difficulties encountered in trying to recruit schools to take part in the main phase of the research study. Four schools were approached, with two schools that initially agreed to take part deciding to withdraw draw due to the mounting pressures for them as schools and their teachers in terms of time. However, the remaining two schools and their science departments agreed to participate. Even though other studies (see Appendix 3) have conducted similar research in only one school, it was felt that in order to increase the trustworthiness of the study and the credibility of the data, then working with teachers in multiple establishments would be beneficial for the research in terms of credibility, transferability and confirmability. Table 3.2 provides background information of the contexts of both of the case study schools.

School	**1**	**2**
Gender	Mixed	Mixed
Age range	11-16	11-18
Approximate number of students	1000	1400
Phase	Secondary	Secondary
Type of establishment	Academy convertor	Community school
Percentage of students eligible for Free School Meals (FSM)	Lowest quintile	Lowest quintile
Level of attendance at this school	Highest quintile	Highest quintile
Percentage of Girls	Second quintile	Second quintile
Percentage of students supported by school action plus or with a statement of SEN	Third quintile	Lowest quintile
Number of Science Teachers	10	13
Number of Participating Teachers	3	7
Ofsted grading at time of study	Outstanding	Outstanding

Table 3.2 Contexts of case study schools

From the analysis of the literature reviewed in Appendix 2, the number of teachers that were engaged in the various studies where teacher interviews were conducted ranged from one to three; with the hours that each was observed varying from one to twelve. Consequently, having used criteria to identify the schools from which the teachers were drawn, this study aimed to recruit a minimum of three science teachers in each school. Sampling of the schools' teacher populations was not undertaken: all members of teaching staff were invited to participate, the teacher participants were volunteers and a collective of ten volunteer participant teachers

engaged to take part. Details of each of the teachers are presented in the next section of this chapter.

When using volunteers one has to be very cautious in making any claims for generalisability or representativeness, as volunteers may have a range of different motives for becoming part of the study (Cohen et al., 2008). However, as has already been discussed, due to the nature of case study research, generalisability is not possible; rather trustworthiness of the findings is the aim. It was felt that even though in principle more time and resources would be needed to conduct a multiple, rather than a single-case study (Yin, 2009), as long it was logistically possible for myself as the researcher to work with all ten teacher case studies, this would be preferred as it would benefit the study by providing 'verisimilitude' - a fuller picture related to the study's aim, add credibility, and accurately represent the 'emic' or insider's perspective (Jalongo, n.d.), therefore being more likely to answer the research questions and provide insights as to those aspects of oral feedback perceived as helping students learn (Stake, 1994; Stake, 1995). Running multiple cases compared to single-case studies should produce a more compelling and robust case, and has the advantage of broadening the coverage of the study (Yin, 2009). This enabled myself as the researcher to start to see the advantages that multiple cases covering different contextual conditions have, as they might substantially expand the transferability of the findings to a broader array of contexts than can a single-case study (Yin, 2009). Thus, helping to contribute understanding related to practical and theoretical implications of oral feedback in science classrooms.

3.5.1 Research Participants

Below are brief descriptions including levels of experience along with details of lessons observed for each of the teacher case studies. Henceforth, throughout the study the case study participants will be referred to as the 'teachers'.

Case Study Teacher - Belle

Belle is a female teacher who has been teaching for two years. Belle has taught in two different secondary schools that were similar in terms of student intake, and is about to take on the role of a lead practitioner in school with responsibility for assessment. Belle was observed and recorded teaching science with four Year 7 classes (11-12 year olds). Lessons covered: cells; cell specialisation; dissolving and diffusion.

Case Study Teacher - Charis

Charis is a female teacher who has been teaching for four years having previously worked elsewhere before entering the teaching profession. Charis has taught in two very different secondary schools, with one having a very high ethnic mix, a large proportion of looked after students and significant behavioural issues, whilst the current school is very different in these respects. Charis is a teacher of science and was observed and recorded teaching science with four Year 10 classes (14-15 year olds). Lessons covered: thermal energy transfer; continental drift; practical assessment skills in planning and reporting data.

Case Study Teacher - Dillon

Dillon is a male teacher who has been teaching for over seventeen years. Dillon has taught in a large number of different secondary schools, he has leadership responsibilities and is a teacher of science with physics as a specialism. Dillon was observed and recorded teaching science with two Year 9 classes (13-14 year olds) and two Year 10 classes (14-15 year olds). Dillon moved schools before it was possible to conduct the final interview with him. Lessons covered: refraction; acceleration; lenses; LEDs.

Case Study Teacher - Eric

Eric is a male teacher who has been teaching for fifteen years. Eric has taught in a three different secondary schools and described the schools as having similar intakes of students, however, Eric believed his current school was exceptional, with students achieving higher grades than in the others in which he had worked. Eric has leadership responsibilities and is a teacher of science with chemistry as a specialism. Eric was observed and recorded teaching science with two Year 13 classes (17-18 year olds), a Year 10 class (14-15 year olds) and a Year 12 class (16-17 year olds). Lessons covered: pH and buffers; titration calculations; composition of atmosphere; melting points.

Case Study Teacher - Flora

Flora is a female teacher who has been teaching for over twenty years. Flora has taught in three different secondary schools, has a curriculum responsibility and is a teacher of science with applied science as a specialism. Flora was observed and recorded teaching science with two Year 12 class (16-17 year olds), one Year 7

class (11-12 year olds) and a Year 13 class (17-18 year olds). Lessons covered: standard solutions; cell specialisation; titrations; spectra analysis.

Case Study Teacher - Garry

Garry is a male teacher who has been teaching for eight years. Garry has taught in a two different secondary schools and has leadership responsibility both within the school and across the local authority, and is a teacher of science with physics as a specialism. Garry was observed and recorded teaching science with two Year 13 classes (17-18 year olds) and two Year 8 classes (12-13 year olds). Lessons covered: EMPA work (externally marked practical assessments); Hooke's law; salt extraction; reflection.

Case Study Teacher - Henry

Henry is a male teacher who has been teaching for three years. Henry has taught in two different secondary schools and is a teacher of science with chemistry as a specialism. Henry was observed and recorded teaching science with two Year 12 classes (16-17 year olds) and a Year 7 class (11-12 year olds); due to timetable changes, one planned observation was lost because of an internet safety presentation by the police, so only three lesson observations could be carried out. Lessons covered: chemistry calculations; multicellular organisms; alkanes.

Case Study Teacher - Isobel

Isobel is a female teacher who has been teaching for two years. Isobel has taught in two different secondary schools and is a teacher of science with biology as a specialism. Isobel was observed and recorded teaching science with two Year 9 classes (13-14 year olds), a Year 10 class (14-15 year olds) and a Year 11 class (15-16 year olds). Lessons covered: proteins; reactivity series; biology revision; graphs.

Case Study Teacher - Jacob

Jacob is a male teacher who has been teaching for three years. Jacob has taught in three different secondary schools and is a teacher of science with physics as a specialism. Jacob was observed and recorded teaching science with a Year 13 class (17-18 year olds), a Year 10 class (14-15 year olds) and a Year 8 class (12-13 year olds); due to the school closing for parent consultation meetings, one of the

booked observations was unable to be carried out; therefore only three were possible. Lessons covered: thermionic devices; test review; salt extraction.

Case Study Teacher - Kris

Kris is a female teacher who has been teaching for ten years. Kris has taught in a two different secondary schools and is a teacher of science with biology as a specialism. Kris was observed and recorded teaching science with two Year 12 class (16-17 year olds), a Year 13 class (17-18 year olds) and a Year 10 class (14-15 year olds). Lessons covered: enzyme catalysed reactions; natural selection; immune system.

Teacher participants were representative of the science teacher population as they encompassed a range of different teaching experiences, genders, age ranges of students worked with, and subject specialisms. A summary of the teacher and student data collected for each of the teachers can be seen in Table 3.3.

Teacher Case Study	**Initial Teacher Interview (Average length approximately 30-40 minutes)**	**Number of Lessons Observed and Recorded (1 hour each)**	**Number of Student Interviews Conducted (Short: up to 5 minutes in length at the end of a lesson)**	**Final Teacher Interview (Average length approximately 30-40 minutes)**
Belle	✔	4	9	✔
Charis	✔	4	7	✔
Dillon	✔	4	11	✗
Eric	✔	4	8	✔
Flora	✔	4	7	✔
Garry	✔	4	11	✔
Henry	✔	3	9	✔
Isobel	✔	4	10	✔
Jacob	✔	3	7	✔
Kris	✔	4	5	✔
	Total	38	84	

Table 3.3 Summary of case study data collected from participants

This data collected across the teachers was analysed not only to identify patterns linked to the foci of this study, but also to indicate similarities and differences across the multiple case studies; the analysis and findings will be discussed in depth in Chapters 4, 5 and 6.

3.6 Research Methods

A case study may call on a combination of techniques, thereby involving a combination of qualitative and quantitative data in order to triangulate or converge evidence on the same research questions and to contribute new knowledge and provide new perspectives (Mercer, 2010; Tong, Sainsbury & Craig, 2007; Yin, 2009). Findings will then be less open to criticism than if they had resulted from, and possibly been biased by, a single data collection method (Yin, 2009). This study uses observations, field notes, audio recordings, and interviews with teachers and students.

The toughest methodological challenge of researching classroom oral interactions is that talk functions in a temporal context (Mercer, 2010). This is in part due to classroom education occurring over time, with interactions "located within a historical, institutional, and cultural context" (Mercer, 2010), meaning that roles are established and positioned, and norms and expectations developed through concerted activity to develop a social climate within any classroom that shapes the processes of teaching and learning (Mercer, 2010; Scott, 2007). Consequently, participants draw on their shared histories throughout interactions, which may or may not be understood or noticed by anyone researching the environment (Mercer, 2007). Therefore, ensuring that data are collected over a suitable timescale, along with appropriate methods, and data analysis are essential if understanding of such contexts is to be achieved (Mercer, 2007; Scott, 2007). Consequently, the teacher case studies used a number of different data collection methods over time, in order to answer the research questions as well as providing a thick description of the teacher case studies being investigated. As will be reported in the data analysis section 3.7, both qualitative and quantitative approaches were employed to examine the data and build understanding (Mercer, 2010). The main methods used were: observations; interviews; field notes; recordings. Table 3.4 summarises the research methods used to answer each of the research questions.

Research Question	Research Methods
1. *How do science teachers conceptualise feedback and perceive their feedback practices including oral feedback?*	Initial interview with teachers Final interview with teachers
2. *What characteristics of oral feedback do science teachers perceive as improving learning?*	Initial interview with teachers Final interview with teachers
3. *What types of oral interactions do students perceive as helping learning?*	Interviews with students
4. *To what extent and in what ways do science teachers' oral interactions compare to their conceptualisation of oral feedback and students' perceptions of what helps learning?*	Lesson recordings Lesson observations Field notes

Table 3.4 Summary of research questions and methods used

Most studies that have investigated feedback practices and classroom interactions have drawn on multiple research methods to provide evidence with: interviews; recordings; classroom observations including field notes; and transcription of interactions, with subsequent analysis of said transcripts being the most dominant instruments used (see Appendices 2 and 3). This study utilised similar methods and discussions regarding the impact of the pilot study on their development, and the reasons for this along with the strengths and limitations of each is covered in the following sections.

3.6.1 Observations

Education studies that want to produce findings relevant to other contexts could include classroom observations as part of the methods employed (Timmons & Cairns, 2010). Subsequently, lesson observations were one of the methods utilised in this study. The total number of hours that an individual teacher was observed in similar studies working across two schools (Chin, 2006; Knight, 2003; Mercer et al., 2009; Murtagh, 2014. see Appendix 2), ranged from a minimum of three hours to a maximum of twelve per teacher. However, similar studies usually worked with two teachers. It was therefore decided that in order to collect sufficient data across ten teachers, then the desired aim was to observe a minimum of three hours, to be comparable to previous studies, and a maximum of four hours. This gave a range

across the study of between 30 to 40 hours of lesson observations, which in the light of other studies, was felt to be a sufficient amount of data to gather. In total, 38 hours of lessons were observed and subsequently evaluated.

Observations enabled data to be gathered on: the physical setting; the human setting; the interactional setting; and the programme setting (Cohen et al., 2008). The most valuable of these was the interactional setting, as it was the oral communications that occurred between teachers and their students that were of upmost importance. Observations can take different forms, dependent on what is being researched. As such, observations lie on a continuum from unstructured through to structured, with semi-structured being an option in between (Cohen et al., 2008, see Table 3.5). This study conducted semi-structured observations, as it was known in advance that oral interactions between teachers and students were being examined; however, the characteristics and form that these oral interactions would take was unknown and indeed the foci of this study.

Type of Observation	**Description**	**Observation Approach**
Structured	Will know what in advance is being looked for (*pre-ordinate observation)* – data gathered to conform or refute.	Observation categories worked out in advance and data gathered in a structured way.
Semi-structured	Has an agenda of issues - data gathered to illuminate issues and suggest explanations.	Observation to gather data around issues, done in a less predetermined or systematic manner.
Unstructured	Little clarity over what is being looked for - data gathered to suggest hypotheses.	Observation of what is taking place to gather data and then decide on its significance for the research.

Table 3.5 Categorisation of approaches for use during observations

Cohen et al. (2008) characterise observations as a type of non-interventionist research method, where observations categorised as non-interventionist are when “researchers do not seek to manipulate the situation or subjects, they do not pose questions for the subject, nor do they deliberately create ‘new provocations’” (Adler & Adler, 1994, p. 378). Qualitative researchers aim to catch the dynamic nature of events, to see intentionality, and to seek patterns over time (Cohen et al., 2008). Non-participant observation involves observing whilst

standing aloof from the group of activities under investigation and eschewing group membership (Bryman, 2012; Cohen et al., 2008). Unstructured observing tends to be direct and naturalistic – it is not constrained by preordained designs or intent, but seeks to document or interpret issues and incidents in the particular context in naturally occurring circumstances (Simons, 2009). Accordingly, unstructured observations noting various aspects of the classroom environment, particularly pertaining to the oral interactions undertaken between the teacher and the students, were conducted.

If, as the researcher, I know in advance what I wish to observe, i.e. if the observation is concerned to chart the incidence, presence and frequency of elements, then there is justification in terms of time efficiency to go into a situation with a prepared observation schedule (Cohen et al., 2008). Subsequently, during the pilot phase of the study a structured observation schedule was devised and utilised to analyse oral interactions as they occurred (see Appendix 4). The various categories listed on the observation schedule were drawn from reviewing the literature around the subject of feedback and the use of AfL strategies.

An observation schedule recording system must be easy to operate and complex systems are undesirable, since the efficacy of structured observations schedules may be difficult to achieve on occasions, due to such effects as observer fatigue and lapses in attention (Bryman, 2012). Observation situations also carry the risk of bias due to a number of different factors: the selective attention of the observer; reactivity; attention deficit; validity of constructs; selective data entry; selective memory; interpersonal matters and counter-transference; expectancy effects; decisions on how to record; the number of observers; and the problem of inference (Cohen et al., 2008).

The pilot phase helped to identify that this method was not suitable as it was ‘too complex’ (Bryman, 2012), limited in scope as it only captured data during whole class work, and not grounded in students’ perceptions and experiences. Subsequently, some of the richer data relevant to the research questions were being overlooked. Consequently, instead of completing an observation schedule during the lessons in the main phase, non-participant observation was used in order to gather rich and more relevant data to address the research questions.

Missing the ‘rich data’ or critical incidents had been one of the drawbacks of the pilot study. Critical incidents are events that can be non-routine, occurring only occasionally but which can be very revealing and offering an extremely important

insight into a person or situation (Cohen et al., 2008). These may be one off instances; however, they may be so important as not to be ruled out simply because they occurred only once (Cohen et al., 2008). Therefore, noting critical incidents was important for the research aim, and a further argument for not using the structured observation schedule as in the pilot study. As a non-participant observer, a running description of the lessons was kept, in particular focusing on the teacher and any critical incidents with regards to oral interactions they had with students. In the next section an example of the field notes taken during one of the lessons can be seen, which shows how points of interest in the lesson related to the oral interactions were noted (see Figure 3.1). The students identified for interviewing were linked to these interactions. It is "this form of observation that is most adopted in case study research to document an incident or event, explain the culture or aspects of the culture, or provide the basis for interpretation of data obtained by other means" (Simons, 2009, p. 16).

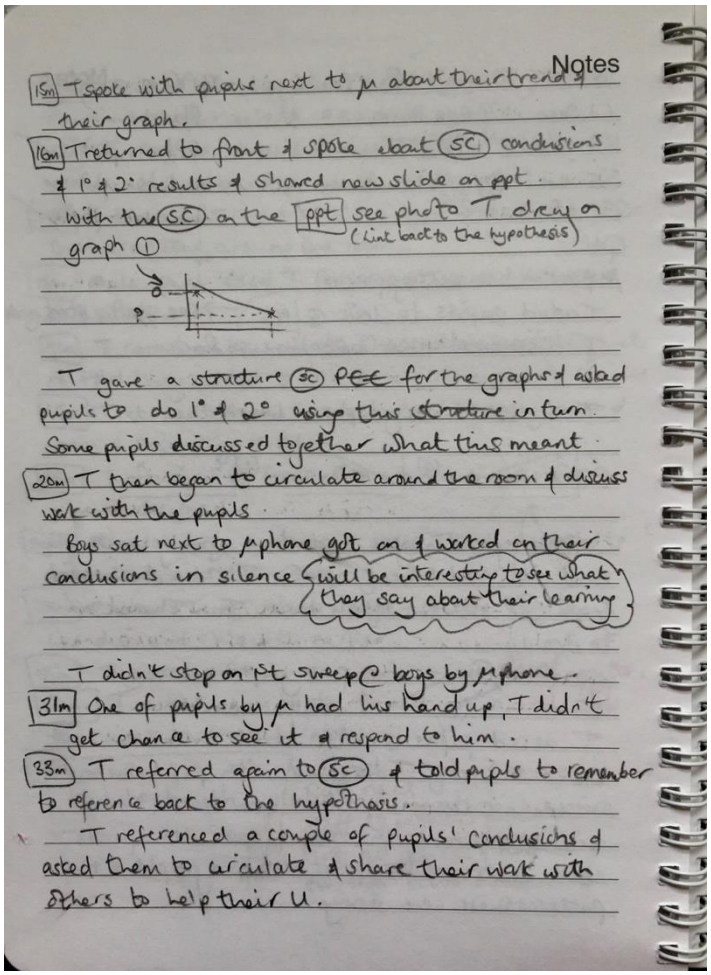
One limitation of this research method is that observing phenomena can change them. Undertaking a non-judgemental approach mitigated this, along with spending extended time in schools and departments with teachers and students. Further considerations of the influence my researcher position has on the trustworthiness of the research methods will be discussed later in Section 3.8.

3.6.2 Field Notes

It was hoped that video recordings would be undertaken in the study to provide an unbiased view of the classroom, as they are a method commonly utilised by other researchers investigating similar issues (see Appendices 2 & 3). However, the headteacher in one of the schools vetoed their use, so it was not employed with any of the teachers. Nevertheless, there are limitations associated with the use of videos, such as reactivity (changes to the participants' behaviours as a direct consequence of the presence of the equipment) and selectivity (the captured field of vision of the device whether fixed or movable) (Cohen et al., 2008). Therefore, the use of field notes became more significant as a way of mapping the richness of the classroom environment, and much more than just a prose account of the lesson.

Due to the frailties of human memory, researchers have to take notes that need to specify key dimensions of whatever is observed or heard (Bryman, 2012); in this study, that included identifying what the purpose of the learning was. The field notes taken identified how the teacher managed the classroom (whole class, small group work), any aspects of conversations that were undertaken and could be

heard, e.g. interactions about success criteria, notes of what the teacher showed and discussed with the class, for example drawings on the whiteboard, to gain an detailed understanding of the classroom context and to make connections between teachers' practices and students' perceptions. Observations can include both oral and visual data (Cohen et al., 2008); therefore, digital images of the lesson were taken if they were thought to be beneficial in capturing data related to the research questions. However, caution needed to be employed when taking digital images as they can impact on behaviour. Nevertheless, by seeking permission for photographs in advance, cameras are likely to be forgotten about very quickly (Somekh & Lewin, 2011). Therefore, consent was obtained, and in order to be as unobtrusive as possible, a mobile phone camera was used. Field notes were completed for every classroom observation. Figure 3.1 provides an example taken from the field notes of one of the lessons observed.


Notes

15m T spoke with pupils next to μ about their trends & their graph.

16m T returned to front & spoke about (SC) conclusions & 1° & 2° results & showed new slide on ppt. With the (SC) on the [ppt] see photo T drew on graph ① (link back to the hypothesis)

T gave a structure (SC) ~~PEE~~ for the graphs & asked pupils to do 1° & 2° using this structure in turn. Some pupils discussed together what this meant.

20m T then began to circulate around the room & discuss work with the pupils.

Boys sat next to μphone got on & worked on their conclusions in silence (will be interesting to see what they say about their learning)

T didn't stop on it sweep(e) boys by μphone.

31m One of pupils by μ had his hand up, T didn't get chance to see it & respond to him.

33m T referred again to (SC) & told pupils to remember to reference back to the hypothesis.

T referenced a couple of pupils' conclusions & asked them to circulate & share their work with others to help their U.

Figure 3.1 Extract from lesson field notes

In summary, field notes for the lessons included: (1) the main focus/science topic of the lesson. (2) Any learning intentions specified for the lesson, and where and when they were subsequently referred to, e.g. PowerPoint slides showing learning intentions or success criteria for the lesson. (3) Any interactions regarding success criteria (quality/standards related to goal) for the lesson, and where and when they were subsequently referred to. (4) Any incidents when the teacher supported students with their learning. (5) Records of any notes/images shared with the students, either digitally, e.g. via PowerPoint, or physically, written on whiteboards by the teacher. (6) Recording of any books/resources used by students.

Subsequently, field notes were utilised when analysing the lesson recordings to identify: learning goals; critical incidents; how the teacher was engaging with students (either as a whole class or as individual/small groups); and useful sources of information referred to by students in interviews. Due to the lack of video evidence, the field notes provided a rich source of data to support the thick description achieved for the case studies and was beneficial during the data analysis process, subsequently increasing the trustworthiness of the findings.

3.6.3 Audio Recordings of Teacher Interactions During Lesson

Analysis of similar studies reveals that most employed some forms of recording device (see Appendices 2 and 3). Consequently, for this study audio recordings were collected to capture all of the teacher's oral interactions during the lesson, and to avoid bias and to build a thick description. There are many advantages to using audio recording including: improved accuracy; releasing the researcher from having to write down everything; and creating opportunities to check data after the event (Simons, 2009). As such, "comprehensive audio-visual recording can overcome the partialness of the observer's view of a single event and can overcome the tendency towards recording only the frequently occurring events" (Cohen et al., 2008, p. 407).

During the pilot phase of the study, audio recordings were taken by using a device placed at the back of the classroom. Analysis of these recordings provided limited data, as it was difficult to hear interactions in the classroom other than those from the teacher to the whole class, due to the noise levels captured on the device and the distance of the teacher from it. These findings concur with the point made by Somekh and Lewin (2011) who state that one of the main limitations of audio recording is the quality of the recording. Somekh and Lewin (2011) advise using a

high quality device that can be placed close to where the data is being captured. For this study it was vital that every oral interaction that the teacher made was captured; therefore, the microphone was taped to the teacher for the full duration of the lesson. Another microphone was also placed in the room near to the students as a back up, in case the microphone worn by the teacher stopped functioning during the lesson. Limitations of digital recording are that the device can have an impact on the behaviour of the participant or others in the environment being studied. Again, it is through gaining informed consent and negotiating a code of practice that these can be mitigated against (Somekh & Lewin, 2011). Unlike studies where only classroom dialogue in whole-class settings, and a few small group interactions or small sections of the lesson was recorded (Chin, 2006; Voerman et al., 2012), this study captured every oral interaction the teacher undertook. Therefore, the findings of this study are more robust, as everything the teacher said was captured and these comprehensive audio recordings served as a primary source of data in answering research question four, and facilitated a mixed methods approach to analysis, see section 3.7.

3.6.4 Interviews With Teachers

During the pilot phase, interviewing was a research method that was not employed as only classroom data were collected. There has been a paucity of studies that have examined feedback from both teachers' and students' perspectives, especially in authentic secondary science classrooms (see section 2.10.1). Interviews are beneficial as they enable accessing the core issues in the case study more quickly and in greater depth, by probing motivations, asking follow-up questions, and facilitating individuals telling their stories (Simons, 2009). Due to the emerging research questions requiring data on teachers' conceptualisation, alongside both teacher and student perspectives of oral feedback, it was felt to be the most appropriate method to use to capture participants' thinking. Therefore, the utilisation of interviews was a method employed in the main phase of the research.

Interviews were conducted with each of the teachers at the start of the main phase data collection period, and at the end, after some initial analysis of the data had been accomplished. Educational establishments have transient teacher populations; indeed, one of the teachers moved schools before the end of the data collection phase. Therefore, in order to mitigate against some of the most frequent surprises involved in conducting case study research - the actual availability of the case study data (Yin, 2009) - all of the data were collected over a nine month period

within one academic school year, with a total of 19 interviews being conducted and recorded.

As with observations, there are a variety of different interview mechanisms that can be undertaken, from structured, through semi-structured to unstructured, with benefits and limitations associated with each. The approach to interviewing in qualitative research tends to be much less structured in order to: emphasise generality in the formulation of initial research ideas; focus more on the interviewee's point of view; encourage 'rambling' or tangential talk, as it gives insight into what the interviewee sees as relevant and important; allow the researcher to go off the schedule if new or follow-up questions would benefit the study; be flexible in responding to the direction the interviewees take the interview; afford rich detailed answers; and interview the interviewee on more than one occasion (Bryman, 2012). For this study it was important that teacher participants were able to articulate their thoughts about feedback in order to allow a deeper insight into science classroom feedback. In an interview, people often reveal more than can be detected or reliably assumed from observing a situation (Simons, 2009). In-depth and semi-structured interviews are a mechanism to achieve this, as they allow exploration of the experiences of participants and the meanings they attribute to them (Simons, 2009; Tong et al., 2007). In-depth research interviews, sometimes also called open-ended, have four major purposes: to document the interviewee's perspective on the topic; to promote active engagement and learning for the interviewer and interviewee in identifying and analysing issues; to enable inherent flexibility (to change direction to pursue emergent issues, to probe a topic or deepen a response, and to engage in dialogue with participants); and to create the potential for uncovering and representing unobserved feeling and events that cannot be observed (Simons, 2009).

There is no single right way of interviewing (Simons, 2009). Consequently, as the interviewer I drew on the following success criteria for a successful interview. It involved me being: (1) Knowledgeable: being thoroughly familiar with the focus of the interview. (2) Structuring: giving purpose for the interview, rounding it off and asking whether the interviewee has questions. (3) Clear: asking simple, easy, short questions and avoiding jargon. (4) Gentle: letting people finish; giving time to think and tolerating pauses. (5) Sensitive: listening attentively to what is said and how it is said; being empathetic in dealing with the interviewee. (6) Open: responding to what is important to the interviewee and being flexible. (7) Steering: knowing what they want to find out. (8) Critical: being prepared to challenge what is said. (9)

Remembering: relating what is said to what has been previously said. (10) Interpreting: clarifying and extending meanings of the interviewee's statements without imposing own meaning. (11) Balanced: ensuring they do not talk too much, which may make the interviewee *passive*, or talk too little, which may result in making the interviewee feel they are talking along the right lines. (12) Ethically sensitive: ensuring that the interviewee appreciates what the research is about and its purpose, and that all answers will be treated confidentially (Bryman, 2012; Kvale, 1996).

In addition to these criteria, I needed to encourage participants to talk about issues pertinent to the research question by asking open-ended questions, usually in one-to-one interviews (Tong et al., 2007). All teacher interviews for this study were therefore carried out on a one-to-one basis in order to allow teachers to talk as openly as they wished about the subject, without feeling judged or intimidated, and involved open-ended, semi- structured interviews focused on the participants' points of view; they encouraged rambling; allowed flexibility in deviating from the schedule and followed the teacher's direction; and probed the participants for deeper responses, and teachers were interviewed on more than one occasion.

A limitation of using interviews as a research method was the effectiveness of myself in being able to model all of these criteria and ensure that the interview achieved its purpose. One of the drawbacks of conducting interviews is intervening too soon, and so cutting off interviewees before they get to the heart of their story (Simons, 2009). To resist this temptation, I needed to listen carefully and learn from what the participant was saying (Simons, 2009). However, one should not allow interviewees to dominate the interview entirely and take the interviewer off track from gaining relevant data for the research (Simons, 2009). Consequently, one of the greatest challenges for me was in knowing when to listen and when to question (Simons, 2009).

Having worked for many years as a coach, I was aware of the power of listening, and also the usefulness of having a list of prepared open-ended questions that can be used flexibly to steer the conversation whilst responding to the answers given. I therefore prepared questions ahead of all of the interviews that were open and related to the research questions, and had copies of them and a summary of the study at hand for the interviewees to refer to if they wished. The interview schedules used with both teachers and students can be seen in Appendices 5 and 6. As with the observations, in order to reduce bias, audio recordings were made of

all the interviews and transcripts produced for them all. This allowed more detailed analysis of the discussions to take place after the event, and enabled me to concentrate more on the topic in hand during the interviews.

An additional limitation of interviews is that the evidence gathered is self-reported. However, there are advantages to the self-report method, as it "opens a pipeline to prodigious amounts of unique information about the target of assessment" (Paulhus & Vazire, 2010, p. 235), and allows for clarity of communication. A further drawback of semi-structured interviews can be the amount of time they can take (Simons, 2009; Timmons & Cairns, 2012). Interviews were therefore scheduled in advance at a time that was convenient for each of the teachers, to ensure there was enough time available so that they were worthwhile and productive. On average each interview took between 30 to 40 minutes, with some lasting over an hour.

By following this guidance, rich detailed answers were obtained and full verbatim transcripts of all teacher interviews were produced for the data analysis. The data generated from both the teacher and student interviews were important in answering the research questions as well as adding to the trustworthiness of the findings.

3.6.5 Group Interviews of Students

Alongside the interviews of teachers, purposeful sampling was used as a way of identifying students to conduct conversations with. Research studies have been conducted where perceptions of students have not been gathered (see Appendices 2 and 3); however, "without the learner's perspective, the crucially important affective and interactional aspects of learners' responses to feedback are likely to be missing" (Hargreaves, 2013, p. 230). Findings from studies that explored factors relating to the quality of teacher feedback (see Appendices 2 and 3) could be called into question if student perspectives were not included. Notwithstanding, as this study sought to understand the characteristics of classroom oral interactions related to a theorised definition of feedback, students' views with respect to determining the factors that affect their learning are central to the study. Therefore, it was not possible to answer the research questions without student perspectives being gathered.

Students were interviewed across all secondary phases from Y7 to Y13 (ages 11 to 18). Contrary to the dominant use of student focus groups (see Appendix 3), students were engaged in small groups of one up to a maximum of

four in interviews immediately following the lesson, using the interview schedule Appendix 7. Interviews were conducted immediately after the lessons, when students' perceptions regarding their learning were considered to be paramount, although a limitation is that this immediate response may not reflect learning over time. An additional benefit was that the group interviews involved small numbers of students so that every student was able to articulate their thinking, rather than is the case with focus groups, where dominant characters can lead to non-participation by some members (Cohen et a. 2008). A limitation of using group interviews was that only a small number of students in the classroom were involved. Not only does this have the obvious drawback that the student perceptions gathered might not be representative of everyone, but also that feedback is highly situational, meaning that the same feedback provided to two different learners could have opposite effects (Stobart, 2012). As such, the students interviewed could only indicate ideas and constructs pertinent to their personal perspectives and not those of their peers. Research which focuses on classroom perspectives from a group of students cannot therefore claim to understand student learning, as "individual students can learn quite different things from the same classroom activities because they begin the activity with distinctly different background knowledge and experience the activity differently" (Nuthall, 2007, p. 55). This is why a large number of students were recruited to account for the individualised nature of learning, and to present a rich portrayal to inform practice, establish value and/or to add to knowledge of a specific topic. In comparison to similar studies analysing students' perspectives (Carnell, 2000; Dann, 2015a; Eriksson et al., 2017; Gamlem & Smith, 2013; Gipps et al., 2000; Hargreaves, 2012, 2013, 2014; Peterson & Irving, 2008; Murtagh, 2014; Plank et al., 2014; Vercauteren, 2009; Williams, 2010), ensuring the approaches undertaken in this study represent an adequate representation of students.

Unlike other research studies that used pre-determined questions or questionnaires (Petersen & Irving, 2008; Williams, 2010), this study used semi-structured group interviews, involving the use of probing questions to explore students' thinking. The use of predetermined categories has the potential to limit student thinking and polarise findings, Indeed, Williams (2010) identified that students perceived four reasons why feedback was helpful: (1) It tells me what I had achieved. (2) It tells me what I had done right. (3) It tells me what I have done wrong. (4) It tells me how I can improve. However, the methodology undertaken limited responses and restricted the results to only those pre-determined by the

researcher (Williams, 2010), whereas this interpretivist study is aiming to generate categories of students' preferences from evidence collected.

A number of studies have shown that students are capable of conceptualising and articulating strategies and processes that are beneficial to their learning (Gipps et al., 2000; McCallum et al., 2000; Murtagh, 2014; Weeden & Winter, 1999; Weeden, et al., 2002; Williams, 2010). Contrary to the limitation of self-reporting data discussed with regards to teacher interviews, there is little reason to be concerned with self-reported evidence gathered from students, as under low-demand conditions responses are likely to reflect the students' thinking (Paulhus & Vazires, 2010). Interviews were therefore conducted, and far enough away from the teacher so that the students were unable to be overheard (Petersen et al., 2008).

The students interviewed were chosen from those in the class who had given ethical consent to participate in the study, and because they had engaged with the teacher in an oral interaction either in a small group or one-to-one during the lesson. Only five student interviews were conducted with a single student, and there were a total of 33 group interviews, with between two and four students resulting in 84 students being interviewed in total. In order to gather rich data during group interviews, although participants individually answered the questions, they were encouraged to talk and interact with each other (Tong et al., 2007). The benefit of this technique is that the group interaction encourages respondents to explore and clarify individual and shared perspectives (Tong et al., 2007). To make sure that every student in the group talked a 'gentle' (Kvale, 1996) approach was used, waiting for responses and not afraid of pauses and probing if thinking needed to be explored, especially if students answered 'the same' to a question to which a peer had responded first.

Students were asked a number of questions initially during the interviews linked to the lesson and what they had been learning so as to put them at ease, create dialogue and clarification, reduce potential problems because of terminology and avoid 'leading' questions (Petersen et al., 2008; Vercauteren, 2009). These questions were asked ahead of the two key questions linked to this research study in order to build rapport, relax the students and focus their thinking on their learning. When interviewing students, it is important to ask questions in ways so that students can comfortably respond (Unger, 2003). By creating the opportunity for students to voice their feelings in a context of trust, students have a lot to say about their experience in school as a whole that might be helpful to the teacher (Unger, 2003).

As discussed in the literature review, feedback is defined and used in a range of different ways, as well as being pragmatically and conceptually difficult to understand (Dann, 2018; Hattie, 2008). In school science classrooms feedback is strongly associated with written feedback, and often understood in alignment with school policies and practices, such as D.I.R.T. (Dedicated, Improvement, and Reflection, Time), an approach that was used in the study's schools. Consequently, due to the terminology translation issues associated with the word feedback, and wanting to ensure that findings related to aspects of oral interactions that students' perceived were beneficial for their learning, this study drew on a methodological approach utilised by others (Carnell, 2000; Gipps et al., 2000; Tunstall et al., 1996; Vercauteren, 2009). Therefore, it was decided to use clean and simple language so that little or no misinterpretation could occur, in particular using questioning to elicit thinking from students about feedback without referring directly to the term.

This use of questioning to elicit thinking about feedback without referring directly to the term aligns to work carried out in the field by Tunstall et al. (1996). Whilst describing the methodology that they undertook to produce the widely referred to feedback typology, Tunstall et al. (1996) asked the students whom they interviewed questions relating to their work (How does your teacher help you to make your work better? Does your teacher tell you when your work is good? Does your teacher tell you when your work is not very good?), without any mention of the term feedback. They subsequently introduced the term feedback when they reviewed students' responses whilst interrogating their data using the following questions: Was the feedback mainly evaluative? Was the feedback mainly descriptive? As this study wished to analyse feedback as a mechanism for supporting learning, the questions asked were phrased in relation to learning rather than work, the term utilised by Tunstall et al. (1996). This approach also afforded students the opportunity to decide for themselves what was important to their learning, exemplifying an interpretivist epistemological approach. The two questions that the students were asked regarding what they perceived had helped their learning in the lessons, and which were subsequently interrogated against the conceptualisation of feedback presented by this study, were:

1. *'What helped you learn in the lesson?'*
2. *'Was there anything the teacher said that helped you learn? If yes, what was it and how did it help?'*

Incidentally, the term feedback was used with teachers. However, to counter the limitations described, time was taken to probe their understanding about its meaning returning to the idea from different angles in order to elicit their perceptions and their uses of it. However, it is noted that there may be alternative views even from teachers regarding the conceptualisation of, and practice repertoires associated with feedback. This was to ensure that the data derived from these discussions was trustworthy. Therefore, even though a small number of students were interviewed from each class, and the findings self-reported, they are still of relevance and valuable for the field; the data gathered from student group interviews will be drawn on to answer research question 3 and explored in Chapter 6.

3.7 Data Collection and Analysis

The data collected in this study was gathered from: teacher interviews; student interviews; lesson observations, field notes; audio recordings. This section will examine how the data were collected and analysed utilising grounded theory. Issues pertaining to trustworthiness and ethical considerations are also addressed.

3.7.1 Data Procedures

Before data analysis occurs, data need to be collected in a way that makes any findings ascribed to it trustworthy. Data collection and the range of strategies to consider in advance for the different types of data and procedures used for gathering them involve: (1) gaining permissions. (2) Conducting a good qualitative sampling strategy. (3) Developing means of recording data both digitally and on paper. (4) Storing the data. (5) Anticipating ethical issues that may arise (Creswell, 2013). For this study, all stages were considered in advance of data collection. Points 2 and 3 have been addressed in previous sections of this chapter and points 1, 4 and 5 are covered later. Creswell (2013) proposes a model constructed from interrelated activities that helps visualise the data collection process; he terms this model the ‘Data Collection Circle’ (see Figure 3.2).

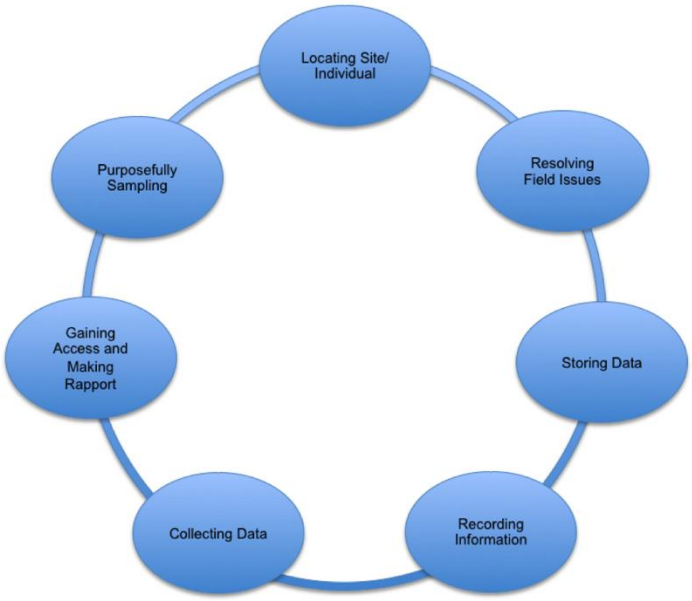


Figure 3.2 Creswell's data collection circle

This demonstrates how interrelated activities are aimed at gathering good information to answer emerging questions, and an investigator can start on the model at different entry points (Creswell, 2013). In the study as soon as data collection began, data analysis was instigated. In order to provide clarity as to when different data were collected and analysed throughout the main phase of the research study, a timeline summarising the various processes has been provided Figure 3.3, and Table 3.6 provides details regarding the different purposes of each data.

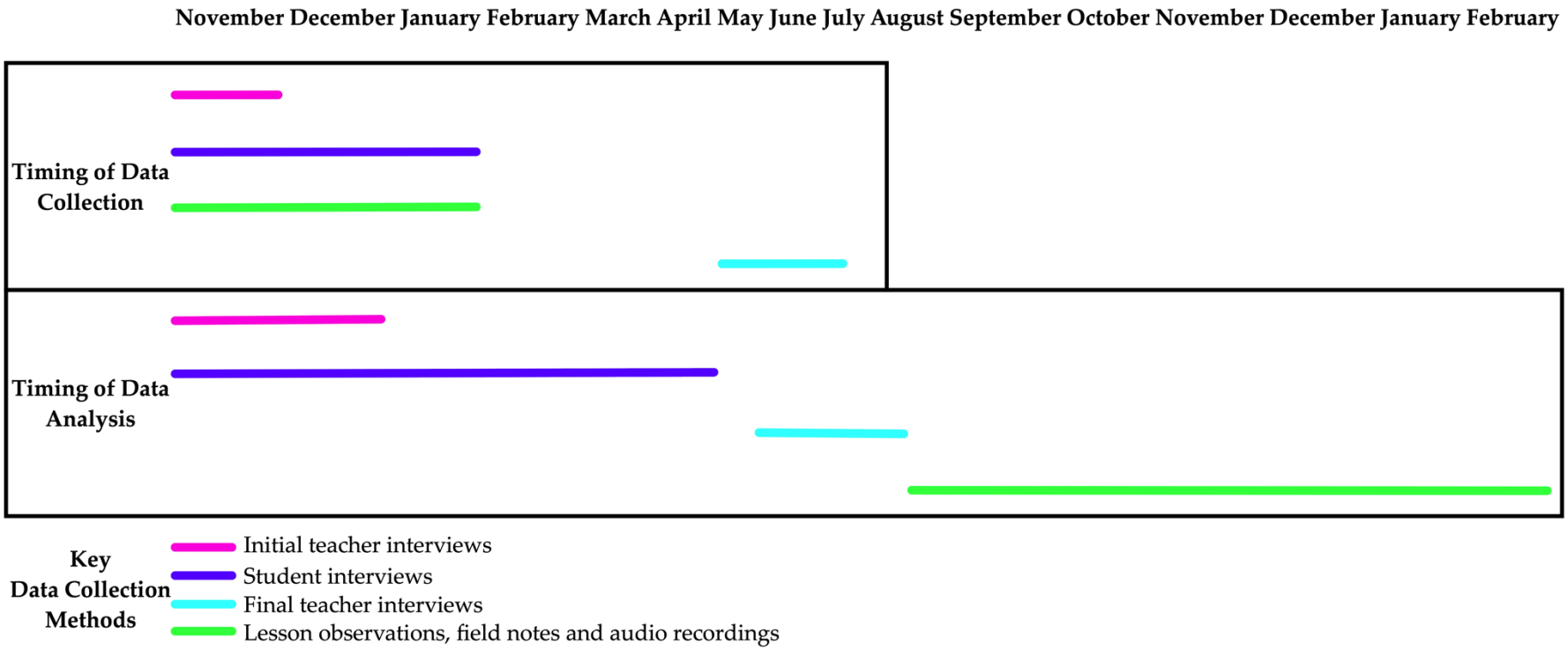


Figure 3.3 Timeline of data collection and analysis

Procedure	Purpose of Data Analysis
Initial teacher interviews	Analysis of transcripts of all initial teacher interviews, alongside the conceptualisation of feedback presented began as soon as the interviews were conducted to answer research questions 1 and 2. Codes and themes emerged and were subsequently employed in the analytical framework used to analyse classroom practice after all lessons had been observed.
Student interviews	Analysis of transcripts of all student interviews, alongside the conceptualisation of feedback presented began as soon as the interviews were conducted to answer research question 3. Codes and themes emerged and were subsequently employed in the analytical framework to analyse classroom practice after all lessons had been observed.
Final teacher interviews	Analysis of transcripts of final teacher interviews began as soon as they were collected to add further details to the answers to research questions 1 and 2.
Lesson observations, field notes and audio recordings	Analysis of lesson recordings commenced once all previous data had been coded. Lesson recordings were analysed using the analytical framework generated from teacher and student interviews alongside the conceptualisation of feedback presented, and lesson observations to answer research question 4.

Table 3.6 Purpose of data analysis for each research method

Analysis involves applying the procedures to the data to allow them to be organised, accounted for and made sense of, in order to produce findings and/or theory and an overall understanding of the case being researched (Cohen et al., 2007; Simons, 2009). Therefore, teacher and student interviews, and field notes were examined before analysis of any lesson recordings, in order that findings from these data aided understanding of what was occurring in the science classrooms. However, it is worth noting that data analysis is carried out in terms of the participants' definitions of the situation (Cohen et al., 2007), and the data analysis stage is fundamentally about data reduction; unless the amount of data collected is reduced, then it is more or less impossible to interpret the material (Bryman, 2012). The method taken by this study to analyse the data was that of grounded theory. The methodological steps and benefits and drawbacks of grounded theory are discussed in the next section.

3.7.2 Analytical Approach

Creswell (2013, see Figure 3.2) suggested a structured approach to data collection to ensure the gathering of good information to answer emerging questions. Another useful model for the qualitative researcher is grounded theory,

as it is the discovering of theory from data systematically obtained from social research (Glaser & Strauss, 2012).

> *Those who can tolerate confusion and regression love the openness of grounded theory and the chance to really generate concepts that make sense of what is going on. They have come to grounded theory to escape preconceived problems, concepts, and format methods of data collection and the processing of it. They wish to escape producing the irrelevance that is based on approved formed methods (Glaser, 1999).*

Due to the ontological position and epistemological aims of this study to build knowledge from the evidence, grounded theory was the approach undertaken in order to make sense of what occurred in the science classrooms of the teachers, grounded in literature and views of students.

Not all research grounded in data can be claimed to be grounded theory. Rather, grounded theory is a specific methodological package, which moves a study from systematically collected data through several steps to the production of a multivariate conceptual theory (Glaser, 1999). There are also drawbacks associated with grounded theory, and a grounded theory researcher needs to have three important characteristics: (1) an ability to conceptualise data. (2) An ability to tolerate some confusion. (3) An ability to tolerate confusion's attendant regression (Glaser, 1999).

These abilities are important, as one has to "wait for the conceptual sense making to emerge from the data. This is just a fact" (Glaser, 1999, p. 838). Due to the nature of constant comparison and "waiting" associated with grounded theory, novice researchers can become anxious with the methodology (Heath & Cowley, 2004). Heath and Cowley (2004) highlight the tension between a need to understand grounded theory methodology and a recognition that the novice researcher can only find out about the process by carrying out the process, which Glaser (1999) states takes time to fully learn. Therefore, even though there may be limitations due to my experience as a researcher, and I certainly felt the confusion when I was faced with the large volume of data analysed, grounded theory was justified as the methodological approach for the data analysis. As a novice

researcher, I set aside the anxiety of 'doing it right' and adhered to the principles underpinning grounded theory, so as to generate understanding from the data (Heath & Cowley, 2004). Subsequently, "grounded theory raises the conceptual level of the study, which gives the researcher a continually transcending perspective, a constantly larger and less bounded picture" (Glaser, 1999, p. 840).

Grounded theory has been described as an inductive approach used with qualitative data, where data is collected and analysed iteratively in order to generate theory, achieving a close fit between the two (Bryman, 2012). However, grounded theory is a general method, and as such can be used with any data or combination of data, e.g. in qualitative, quantitative and mixed methods methodologies (Glaser, 1999). Indeed, in many instances both forms of data are necessary for mutual verification, so that through the comparison between different types of data on the same subject theory can be generated (Glaser & Strauss, 2012). Consequently, the research methods outlined in the previous section were systematically employed to gather data throughout the research process, and the generation of some quantitative and quantitative data and grounded theory methodologies were utilised as soon as data collection commenced (see Figure 3.3), with the first of these being to code the data. The analytical framework that was developed to analyse teachers' classroom practice was developed using grounded theory, as the categories of oral interactions within it were all 'grounded' in literature (due the conceptualisation of feedback presented in Chapter 2), along with teachers' and students' perceptions, and observations from field notes, ensuring that all oral interactions were included in the data analysis to generate theory, as per the interpretivist epistemological orientation of the study.

3.7.3 Coding and Constant Comparison

Coding is one of the most central processes in grounded theory, and unlike quantitative research that requires data to fit into *preconceived* standardised codes; in grounded theory the researcher's interpretations of data shape his or her emergent codes (Bryman, 2012). Therefore, the codes that emerged from the utilisation of grounded theory whilst interpreting the data in this study align to the theorised conceptualisation of feedback derived from the cross-sectional analysis of the literature examined in Chapter 2. If grounded theory were repeated using an alternative conceptualisation of feedback, then the findings presented would be different. Nonetheless, due to the measures undertaken to ensure the trustworthiness of the study, if others interpret the data using the definition of

feedback central to this study, then grounded theory would afford the same findings from the same data.

A *coding unit* is the smallest element of material that can be analysed, and the creation of units of analysis can be achieved by ascribing *codes* to the data: i.e. labels are given to the coding units identified (Cohen et al., 2007). Ascribing code is the process of disassembling and reassembling the data, which involves reviewing transcripts, recordings and/or field notes and giving labels (names) to component parts that seem to be of potential theoretical significance, and/or those that appear to be particularly salient within the social worlds of those being studied (Bryman's, 2012; Cohen et al., 2007). Some basic questions to consider helping start this initial coding process include: What is going on? What are people doing? What is the person saying? (Gibbs, 2008). These ideas were drawn on when exploring teachers' conceptualisation of feedback and students' perceptions of what helped them learn.

Interview transcripts were produced as soon as possible after they occurred. In order to manage the data analysis process, once the transcripts of interviews were produced, the NVivo software was utilised to help manage and analyse the large amount of data generated. Coding was instigated as soon as possible in order to ascribe meaning and make sense of the analysed data. This was achieved through: reading through the initial set of transcripts, field notes, documents etc.; doing it again; reviewing the codes; considering more general theoretical ideas in relation to codes and data; remembering that any one item or slice of data can and often should be coded in more than one way; not worrying about generating what seem to be too many codes; and keeping coding in perspective (Bryman, 2012).

There are three types of coding practice (Bryman, 2012; Cohen et al., 2007; Gibbs, 2008) associated with a grounded theory approach as shown in Table 3.7.

Coding Practice	Characteristics of Process	Outcomes of Process	Examples
Open coding	Process of exploring the data and identifying units of analysis to code for meanings through breaking down, examining, comparing, conceptualizing and categorizing data.	Concepts, which can be grouped and turned in to categories and subcategories.	Open questioning
Axial coding	Process of exploring codes by putting data back together in new ways after open coding. Achieved through examining interrelationships between codes. The codes and categories are then compared to existing theory.	Links between categories and codes established, and maybe new categories identified.	Promotion of student-directed learning
Selective coding	Process of selecting the core category (central issue/focus) around which all other categories are integrated and coding scheme compared with pre-existing theory; a 'storyline' that integrates the categories in the axial coding model of the phenomenon of interest.	Core category identified and relationships between it and other codes made clear.	Divergent feedback practices

Table 3.7 Coding approaches in grounded theory

Bryman (2012) and Gibbs (2008) see these three practices as different levels of coding each relating to a different point in the elaboration of categories in grounded theory. Bryman (2012) acknowledges, however, that not all practitioners operate with this threefold distinction.

Open coding, also known as data drive coding (i.e. one has an open mind and initially no ascribed codes, so that as far as possible, meaning arises from the data (Gibbs, 2008)) was instigated as soon as possible. The initial coding of the

teacher and student transcripts was done on a line-by-line basis (Gibbs, 2008). There were a small number of codes, e.g. *discrepancy* information, that arose, that were expected to appear. As Gibbs (2008) states, if the research study has been defined in the context of a theoretical framework, such as the literature pertaining to the efficacy of feedback, then it is likely that as the researcher I will have some ideas regarding some of the potential codes that will arise.

Following this initial coding, further analysis was carried out using axial coding. By categorising the data further, the codes moved from being descriptive to more analytical and theoretical (Gibbs, 2008). There should be repeated coding of data in order that the richness of the data is included in the theoretical formulation (Cohen et al., 2007). Consequently, selective coding was used to produce core codes, which influenced subsequent stages of the study. Some of these codes and themes were employed in the final teacher interviews, in which codes from the perspectives of students were discussed in location to those of the teachers. Subsequently, codes produced from teacher and student interviews affected the analytical framework used to scrutinise teachers' classroom practices. Therefore, grounded theory as a methodology affected all aspects of the data examination, as emergent themes were used to underpin all of the data analysis undertaken.

The conceptualisation of the data is a must; however, it can fail if it is not submitted to another key aspect of grounded theory: that of constant comparison (Glaser, 1999). This is tedious and something that not all researchers have the ability to achieve (Glaser, 1999). A seven step approach of synthesising both coding and constant comparison processes associated with grounded theory (Cohen et al., 2007; Gibbs, 2008) was utilised with the data in this study (see Table 3.8). Grounded theory that was produced as a consequence of applying the seven steps was done so through an iterative process, moving backwards and forwards between data and theory until the theory fitted the data (Cohen et al., 2007). This is in contrast to much conventional research in which a more linear approach is taken.

Step of Data Analysis Process	Key points relating to it.	Approaches Used
1. Establish units of analysis of the data	Indicate how the units are similar to and different from each other. Each unit of analysis should be as discrete as possible whilst retaining fidelity to the integrity of the whole.	Transcripts used (paper and electronic to read through data). I remained open-minded and considered what was going on? What were people doing? What was the person saying? I coded on a line-by-line basis.
2. Create a 'domain analysis' – a domain being a category, which contains several other categories	Group together items and units into related clusters, themes and patterns.	I grouped together similar and homogeneous subsamples; and used multiple codes as necessary.
3. Establish relationships and linkages between domains	Ensure the data, their richness and 'context groundedness' are retained. Identify confirming cases, by seeking 'underlying associations' and connections between data subsets.	I compared codes across different participants, tested and evolved, as needed going backwards and forwards across the transcripts, and lesson recordings.
4. Making speculative inferences	Hypothesis generation, or setting of working hypotheses that feed into theory generation on the basis of the evidence. Include some explanations for the situation, some key elements and possibly their causes.	I asked as a series of 'what ifs' to explore all dimensions of the findings and data; and continued to compare data, codes and themes.
5. Summarizing	Write a preliminary summary of the main features, key issues, key concepts, constructs and ideas encountered to date.	I started to produces theories; continued comparing ideas with the themes and codes in the data and evolved them as needed.
6. Seeking negative and discrepant cases.	Seek confirming cases, weigh significance of disconfirming cases against theory generated and adapt the hypotheses accordingly.	I compared theories across data sets to seek exceptions; if they arose, I considered how they fit with the codes and added or amended as needed. I saturated all data so that everything linked.
7. Theory generation	Theory is grounded and emerges from the data.	Finally I produced findings

Table 3.8 Grounded theory steps and strategies

It is important to not that "constant comparison, the data analysis method, does not in and of itself constitute a grounded theory design" (O'Connor, Netting & Thomas, 2008, p.41), as the process of constant comparison does not by itself ensure the grounding of data, whether "grounding" is used in a positivistic or interpretive sense (O'Connor et al., 2008). What is needed in constant comparison,

is that all data are systematically compared to all other data in the data set; therefore no data can be ignored or not considered. This assures that all data produced are analysed rather than potentially disregarded on thematic grounds (O'Connor et al., 2008). It is the timing and the process of this constant comparison that determines whether the analysis is deductive and will produce a testable theory, or whether the analysis is inductive and will build a theory for a particular context (O'Connor et al., 2008). In order, therefore, that the theories generated in this study were grounded in the data, every interview of every teacher and student along with every lesson recording were analysed and compared on an on-going basis.

Interestingly, Simons (2009) presents a definition for the interpretation of data alongside that of analysis. Interpretation, she claims, is "an understanding and insight you derive from a more holistic, intuitive grasp of the data and the insights they reveal" (2009, p. 117). This approach to interpretation is covered in the seven step process from step three onwards (Cohen et al., 2007). Indeed, Simons (2009) goes on to declare that though it is possible to make a distinction between analysis and interpretation, it is also important to state that these are not discrete processes, so even though Simons (2009) puts forward the idea of two different activities, as long as researchers conduct well grounded data analysis, then both analysis and interpretation may be present to different degrees at different stages, as they are interactive and iterative throughout the research and in one's thinking.

Therefore, throughout the data collection period of the main phase of the study, data were constantly analysed in order to code them and to identify themes and patterns as they were occurring; firstly the teacher and student interviews were coded, and then after all of the lesson observations, so were the audio recordings. This constant analysis on its own was not enough; the codes and themes were returned to and further analysed in order to review and build on them. The data were coded several times to ensure the trustworthiness of the codes and themes generated, and to ensure the reciprocal relationship between data and theory took place. This inductive approach was used to generate substantive codes from the data; the developing theory suggested where to go next to collect data and which more-focussed questions to ask; this is the deductive phase of the grounded theory process (Scott, 2009). Codes generated for all oral interactions coded in this study, along with details of where they originated from can be seen in Table 6.1 and Appendix 9 respectively. Discussions related to other themes generated from the data form the analysis of chapters 4, 5 and 6.

Chin's (2006) study developed an analytical framework to: represent classroom talk; find out how teachers used questioning in science to engage their students in thinking; and identify the various forms of feedback provided by teachers in the follow-up move of the initiation-response-follow-up format of teacher exchange. Chin (2006) used the analytical framework with a focus on teacher–student exchanges and questioning oral interactions. However, Chin's framework was only used for oral interactions that occurred during whole-class teaching, with small instances of teacher-group talk, and the unit of analysis only the IRF exchanges, where questions were used as the opening 'I' interaction. This meant that large sections of the classroom dialogue were not recorded, and other oral interactions types not analysed. Whereas, the analytical framework (Appendix 9) used in this study was developed to capture data from every oral teacher interaction and the categories used within in it were generated from the interviews and lesson observations to cover all oral interaction types. The analytical framework was used when listening to the lesson recordings, and event sampling was employed so that every instance of every oral interaction was tallied and coded against the different oral types. It was also noted using field notes, whether the interaction had occurred during whole-class or small group/individual teaching. One limitation of this approach is the lack of timing or chronological information associated with the tallies; e.g. every time the teacher changed the type of oral interaction in which they were engaging, this was noted, so if a teacher was giving task instructions for five minutes then only one tally would be noted on the analytical framework. Another limitation of coding is that it depends on the decontextualized identification of language features and therefore is unable to handle meaning, or the history of dialogue between teachers and students (Mercer, 2010). To help mitigate against these issues, as the researcher I was an experienced science teacher, and ideally placed as an 'insider-outsider' (see section 3.8.2) to identify function from the teacher's perspective. Consequently, a free flow column was added to the framework so that timings of noteworthy occurrences were recorded, and key sections of the lessons transcribed to provide illustrative descriptive passages. The detailed analysis of the lessons and the subsequent findings are discussed in Chapter 6.

In summary, grounded theory, with the key features of coding and constant comparative analysis of the evidence collected from teacher and student interviews and lesson recordings, was conducted throughout the whole of the study, to categorise oral feedback interactions, which led to the conceptualisation of the data

and subsequent findings. For this study, coded oral interactions that were classified as oral feedback had to meet two criteria:

1. They aligned to the theoretical conceptualisation of feedback derived for the literature.

   Useful information provided from an agent (teacher, peer, book, parent, self or personal experience) which supports learning, relates to learning goals, regarding aspects of one's performance or understanding, and is utilised to improve one's learning of science.

2. Students referenced them as being oral interactions that they perceived were beneficial to their learning.

As has been discussed, a limitation is the lack of experience of the researcher. However, grounded theory as an approach empowered myself as the researcher to be freed in order to be my own theorist (Glaser, 1999), and as will be shown in the data analysis chapters, because findings were compared across different data sets, e.g. teachers' perceptions against students', this increased the conceptual level of the study and findings.

3.8 Ensuring the Quality of Qualitative Research

The need for an alternative to reliability and validity for qualitative research is due to there being more than one, and possibly several, accounts of social reality, rather than a presupposed single absolute version (Bryman, 2012). Alternative criteria related to the trustworthiness of a study can be discerned for evaluating and judging the quality of qualitative research (Bryman, 2012; Lincoln & Guba, 1985). The criteria upon which the trustworthiness of this study was established are summarised in Table 3.9 (Bryman, 2012; Lincoln & Guba, 1985).

Aspect of Trustworthiness	Characteristic of Aspect	Techniques Employed	Equivalent Criterion in Quantitative Research
Credibility	Confidence in the 'truth' of the findings and in that the study was carried out according to good practice.	Triangulation (multiple perspectives were used to build understanding).	Internal validity
Transferability	Showing that the findings have applicability in other contexts.	Thick and rich description (a detailed account of field experiences was constructed).	External validity
Dependability	Showing that the findings are consistent and could be repeated.	Complete records of all phases of the study were kept and maintained.	Reliability
Confirmability	A degree of neutrality, or the extent to which the researcher acted in 'good faith', so that findings are shaped by the respondents and not researcher bias, motivation, or interest.	Triangulation (multiple perspectives were used to build understanding).	Objectivity

Table 3.9 Aspects of trustworthiness

As indicated, a key strategy was the use of triangulation through the collection and analysis by drawing on various perspectives. In qualitative casework, triangulation (e.g. drawing upon multiple perceptions/sources of data) is an approach that is often used by researchers to increase the trustworthiness of their re-presentation of the case (Stake, 1995). Triangulation may take several forms, but commonly refers to the employment of multiple data sources, data collection methods, or investigators (Long & Johnson, 2000). Furthermore, in general, the purpose of multiple types is to reduce the disadvantages inherent in the use of any single source, method or investigator. Asking the wrong question is the source of most errors, and the utilisation of triangulation is held to be an effective device to prevent this (Long & Johnson, 2000). Therefore, triangulation of the various research methods used in the study and throughout the data collection process was

undertaken, not only to increase the trustworthiness but also to ensure that the right questions were being asked, and hence avoid errors.

3.8.1 Inter-rater Agreement

Another mechanism employed to ensure the trustworthiness of the study, especially with regards to the interpretation of the data, was through the utilisation of an experienced researcher. They were recruited and brought up to date with the aims of the study and research questions, and undertook different inter-rater agreement activities. The researcher is a senior lecturer at a north of England University and volunteered to undertake inter-rater agreement work. The difference between inter-rater reliability and agreement is important because discrepancies may arise; for instance, if some coders are more knowledgeable than others about the interview subject matter or about the context in which the data was collected (Campbell, Quincy, Osserman & Pedersen, 2013). Whereas inter-rater reliability requires that two or more equally capable coders operating in isolation from each other select the same code for the same unit of text, inter-rater agreement, on the other hand, requires that two or more coders through discussions are able to reconcile whatever coding discrepancies that they may have for the same unit of text (Campbell et al., 2013). Therefore, due to the data in this study being interpreted alongside the conceptualisation of feedback constructed from the literature, discussions between both parties as per inter-rater agreement activities were the most appropriate way to ensure the dependability of the findings. Campbell et al. (2013) attest that, generally speaking, the issue of inter-rater reliability is discussed frequently in the methods literature, but the issue of inter-rater agreement is not.

There have been a variety of methods to measure inter-rater reliability, and the most traditional approach has been to measure it as a percentage agreement, calculated as the number of agreement scores divided by the total number of scores (McHugh, 2012). There are issues that can arise from such statistical approaches, as they do not allow for agreement that can be accounted for by chance (Cohen, 1968). To this end, Cohen suggested a new measure: the Kappa Coefficient, which provides a conceptually simple measure for agreement (after agreement that can be attributed to chance) has been removed. The range of Kappa values and how they can be interpreted are shown in Table 3.10.

Kappa Value	Interpretation
Below 0.40	Poor agreement
0.40 – 0.75	Fair to good agreement
Over 0.75	Excellent agreement

Table 3.10 Kappa Values and Levels of Agreement

For this study, inter-rater agreement of interview transcripts involved the second researcher being provided with the codes and uncoded transcripts of three teacher interviews and six student interviews, to check on the codes and consistency of each code descriptor. The researcher was able to identify all themes across the interviews with no additional types required. A resulting inter-rater agreement Kappa Coefficient value of 0.77 was achieved, indicating 'excellent agreement'. An inter-rater agreement activity was also undertaken to increase the trustworthiness of the data analysis of teachers' classroom practice. This involved the second researcher initially coding a recording of one lesson to check the codes and consistency of each code descriptor within the analytical framework. The researcher was able to identify all oral interactions with no additional types required. Once the codes were agreed, the two researchers co-coded one of the lesson recordings. Using SPSS statistics software, a Cohen's Kappa Coefficient was carried out to examine the inter-rater agreement. A value of 0.788 was achieved with the results showing a 100% agreement, again indicating an 'excellent agreement'.

A further consideration with regards to the trustworthiness of the study is the impact that I as the researcher had on all aspects of the study. This, along with approaches taken to mitigate against this, will be discussed in the following section.

3.8.2 Impact of Researcher

One further area to consider and consequently counter, in order to maintain the trustworthiness of the study, is the effect of myself as the researcher. As has been noted earlier, the data and case are viewed primarily through the analysis and interpretation of it from the perspective of myself as the researcher, and are therefore open to bias. One of the most significant impacts, therefore, is the potential effect that my philosophy, beliefs, feelings and personal experience have on all phases of the research process and outcomes; from recruiting the participants, through to the data collection, analysis, interpretation and reporting of

findings (Berger, 2015).

On the one hand, the challenge is that no research is free of the biases, assumptions and personality of myself as the researcher, as it is not possible to separate self from the activities in which one is intimately involved (Sword, 1999). Consequently, to mitigate for this, I made sure that there was "no untrammelled incursion of values in the research process" (Bryman, 2012, p. 39), and ensured that I exhibited reflexivity throughout. Reflexivity involved being both reflective and self-critical in order to: explore my own subjectivity; be increasingly aware of the impact I may have on the research data collected; and increase the sensitivity and analysis of the data (Bryman, 2012; Somekh & Lewin, 2011). The strategies employed for maintaining reflexivity included: repeated interviews with the same teachers, maximising the space in interviews for participants to express their ideas freely (Berger, 2015; Simons, 2009); triangulation; peer review through inter-rater agreement activities; keeping a research journal for 'self-supervision'; and creating an 'audit trail' of reasoning, judgment, and emotional reactions (Berger, 2015). As the researcher, I ensured that I remained constantly alert to the potential of projecting personal experiences and utilising them as a lens through which to view and develop understanding of the participants in the study (Berger, 2015). In conjunction with reflexivity, all criteria and techniques related to establishing the trustworthiness of the study were adhered to throughout.

As a researcher I can therefore not be value-free with respect to prior knowledge and bias; hence, objectivity is a false claim in research, as the personal familiarity of myself as the researcher is an integral part of the entire process (Cohen et al., 2007). Nonetheless, there are advantages to having awareness of the field. Indeed, having personally experienced being a science classroom practitioner, as well as a researcher, afforded me the appropriate knowledge to fully comprehend what it is like to be in certain situations and therefore adequately research them (Berger, 2015). Consequently, understanding of the field may enable better in-depth analysis and interpretation for the study, deepen understanding, and enhance the creation of meaning (Berger, 2015; Sword, 1999), increasing the credibility of the findings and strengthening the integrity of the researcher (Sword, 1999).

However, there are other aspects of being the researcher in an interpretivist epistemology that also need to be given due consideration. There is the 'observer's paradox', which refers to a situation in which the phenomenon of being observed is unintentionally affected by the presence and motives of the observer/researcher

(Cukor-Avila, 2000; Labov, 1972). Not only does having an observer present affect the data collected, but so also do the characteristics of the interviewer (such as gender, age, experience, social background, and race), and the characteristics of the interview itself (such as the relationship between interviewer and interviewee, the strategies used by the field-worker to gather data, the role of the field-worker in the interview situation, and the presence of other interlocutors) (Cukor-Avila, 2000). Whilst Cukor-Avila (2000) debate issues in a specific field of study (sociolinguistic research), it is evident that similar effects could occur whist carrying out work as an observer in classrooms. Therefore, in order to minimise the impact of the observer's paradox on the data collected, I was very conscious of sitting out of the field of vision of students, and in an unobtrusive area of the room, usually at the very back, so as not to impact on the flow of the lesson. Eye contact with either the students or the teachers was also consciously avoided throughout the lessons, and my presence in the lessons was swiftly accepted, as comments asked about my presence in the room were very rare. The item that caused more impact than any other was the microphone that was worn by the teachers. This was commented on by a number of students, and due to its visibility it is worth noting that it may have had some impact on the interactions in the classroom. In order to systematically address these issues, there needs to be a greater concern with the methods used to conduct the interviews and to collect the data (Cukor-Avila, 2000). How methods and data collection approaches have been utilised in this study to ensure trustworthiness has been established previously.

Another aspect of being the researcher that I needed to contemplate is that of the '*position of the researcher'*, and the impact that this has on the trustworthiness of the data. As debated earlier, the position that was taken during the unstructured observations was that of a non-participant observer, i.e. a situation in which the observer observes but does not participate in what is going on in the social setting (Bryman, 2011, p. 273). This researcher position is as an 'outsider', implying that as the researcher I operated outside the study (Somekh & Lewin, 2011), as opposed to an 'insider' or participant observer, a position attributed to a researcher who conducts the research with populations of which they are also a member (Dwyer and Buckle (2009). However, Dwyer and Buckle (2009) discuss the "space between" (p. 60), which they claim challenges the dichotomy of the insider versus outsider status, a construct that they argue is too simplistic an analysis of the complexity of situations. Qualitative researchers are not separate from the study, as they are firmly in all aspects of the research process and essential to it (Dwyer &

Buckle, 2009), consequently operating in the ‘space between’.

In this study, the position undertaken by myself as the researcher was that of one functioning in the ‘space between’. As a previous head of science, science teacher and facilitator of Continuing Professional Development (CPD) for science teachers, I was in a sense an insider, as I have experienced the context and am aware of current issues in education. I was therefore constantly alert and rigorously reflective on how my presence in both interviews and classrooms may shape the study (Berger, 2015). However, as someone no longer teaching in school, I was, to the participants, predominantly the students, an outsider. Other issues with bringing oneself into the researched are the potential of my self-involvement blocking out hearing other voices (Berger, 2015). Therefore, it was important to maintain a fluid position throughout the duration of the study. This was needed to capture the viewpoint of the teachers and students who actually lived the experience, and to develop understanding from the perspective of an ‘objective’ outsider (Berger, 2015).

In order to overcome the separation between the researched, and myself as the researcher non-hierarchical and non-manipulative relationships were established (Berger, 2015; Dwyer & Buckle, 2009). Such relationships were achieved by making the research an interactive experience, in which I brought my personal role into the relationship by “answering participants’ questions, sharing knowledge and experience and giving support when asked” (Dwyer & Buckle, 2009, p. 62). To that end, a significant amount of time was spent prior to the data collection period of the study engaging with all of the teachers, explaining the process, answering any questions and providing any additional support or information needed. CPD sessions were also carried out with both science departments after the study was completed at their request.

To recapitulate, with regards to countering the potential impacts of myself as the researcher, a number of strategies have been discussed with one integral theme being of paramount importance: ensuring the trustworthiness of the study. Trustworthiness was achieved through the study being carried out according to good practice (credibility); demonstrating that the findings have applicability in other contexts (transferability); showing that the findings are consistent and could be repeated (dependability); the extent to which the researcher acted in ‘good faith’, so that findings are shaped by the participants and not researcher bias, motivation, or interest (confirmability). Data were triangulated with inter-rater activities to ensure

that the findings were dependable. It can be claimed, therefore, that themes identified and subsequent findings are convincing. However, the themes themselves are a construct of my analysis viewed through my lens, and as such the knowledge generated from the study is a reflection of the location in time and social space of myself as the researcher (Bryman, 2012). Notwithstanding, the intention of myself as the researcher has been to be transparent and to represent the views of teachers and students who participated in the study accurately. However, replication is needed by future studies to test the trustworthiness further of the findings claimed.

3.9 Limitations

There were a number of small problems that arose during the data collection phase of the study. The most significant limitation of this study is that the headteacher of one of the schools would not allow for any video footage to be collected during lesson observations, leading to its removal from the research design. The lack of a visual record of how the teachers engaged with students may have affected the quality of the findings due to the limited analytical possibilities available from only audio recordings, as it does not capture non-verbal communications. However, there are limitations associated with the use of videos, such as reactivity (changes to the participants' behaviours as a direct consequence of the presence of the equipment) and selectivity (the captured field of vision of the device whether fixed or movable). Analysis showed that although other studies employed video footage as part of their research methods (Chin, 2006; Gamlem & Munthe, 2014; Gamlem & Smith, 2013; Hargreaves, 2012, 2013, 2014; Mercer et al., 2009; Nadeem, 2015; Rutheven et al., 2011; Voerman et al., 2012; Willis, 2011), there were many examples of similar investigations in the field whose research methods did not (Carnell, 2000; Knight, 2003; Peterson & Irving, 2008; Murtagh, 2014; Plank et al., 2014; Williams, 2010). This was a disappointment, as video footage would have afforded the opportunity to observe in greater detail the teacher-student interactions that occurred in the classroom. However, it was felt that employing field notes and using the audio recordings would provide sufficient data to be able to answer the research questions.

An additional uncontrolled factor was not being able to observe all of the teachers in the study for the same number of lessons each, or with the same class, or teaching the same subject specialism. This was due to the nature of school timetables having specific year groups all in science at the same time, and being open to last minute changes due to in-school events and activities such as: a short-notice police assembly; students having to go to attend an emergency form time; a

school altering the teaching times of one of the days. After the planned data collection period was completed, further visits were made to try and collect as much data from the outstanding teachers as possible. Following this additional data collection period, it was no longer feasible to return to the school due to changes in staffing and the time of the school year. Whilst these lessons were only a snapshot of practice, analysis identified consistent patterns. Moreover, as Appendix 2 shows, several other studies have observed teachers as part of their research design for just three lessons. Therefore, for this study to be comparable with other studies in the field, it was decided if at least three lessons had been observed then the data from the teachers could be included.

Thirdly the study was unable to conduct a final interview with one of the teachers as they left the school before the meeting could be conducted. The data from this interview did not impinge on the findings of the study, as a comprehensive initial interview, as well as four lesson observations, field notes and student interviews had been carried out with this teacher, which meant that there was sufficient data to address the research questions from this participant.

However, in spite of these limitations, by drawing on the range of approaches discussed throughout the entirety of this chapter and due to the number of lessons analysed, the repeating patterns distinguished for each teacher and the systematised analysis of the data, the findings are trustworthy, they answer the research questions, and they afford insights into teachers' oral feedback practices in science that add knowledge to the field.

3.10 Ethical Considerations

Simons (2009) expresses ethics as how we behave or should behave in relation to the people with whom we interact. This means establishing throughout the research process a relationship with participants that respects human dignity and integrity and in which people can trust (Simons, 2009). Participants need to know they are being treated fairly, and that if difficult issues arise, these can be discussed and resolved, meeting both the participants' concerns and the researcher's obligation to produce public knowledge (Simons, 2009). Throughout the study, all stakeholders were involved and informed at all stages and close relationships were maintained, with the effective use of communication so that rapport was established and trust built (Berger, 2015).

Alderson and Morrow (2006) discuss the importance of ethics and suggest that researchers' own good intentions are necessary but not sufficient. Researchers also need to refer to long-standing principles of justice, avoiding harm, and respecting participants' views and informed consent (Alderson & Morrow, 2006). British Educational Research Association (BERA) (2011) state clearly that irrespective of how active or passive the participants are in the research process, the educational researchers should operate within an ethic of respect for any persons involved in the research that they are undertaking. Individuals should be treated fairly, sensitively, with dignity, and within an ethic of respect and freedom from prejudice regardless of age, gender, sexuality, race, ethnicity, class, nationality, cultural identity, partnership status, faith, disability, political belief or any other significant difference (BERA, 2011). The ethic of respect should apply to both the researchers themselves and any individuals participating in the research, either directly or indirectly (BERA, 2011). BERA then summarise a list of responsibilities on the part of researchers and stress the need to adhere to this ethic of respect. The responsibilities that they list cover: voluntary informed consent; openness and disclosure; right to withdraw; children, vulnerable young people and vulnerable adults; incentives; detriment arising from participation in research; privacy; disclosure.

The study ensured that the guidance produced by the University of York with regards to ethical considerations was followed. An ethical issues implementation form and ethical issues audit form (see Appendices 10 and 11) were produced. Prior to any data collection taking place, all ethical approaches had to be submitted and receive approval by the University of York's Education Ethics Committee. By following their guidance and adhering to the practices set out, I ensured that, as Alderson and Morrow (2006) stipulated, I was not relying on my own good intentions, but rather I was aware of best practice and ensured the responsibilities as laid out by BERA (2011) were covered.

Homan (2001) stipulates the obligatory need of researchers to inform and obtain the consent of human subjects in social research, although he states that educational researchers are often reluctant to inform their subjects, and investigators sometimes do not so much seek consent as assume it. Consequently, for this study I made sure that I gained informed consent from all of the stakeholders involved in the study ahead of collecting data. Meetings took place between participants and myself at which ethical issues were discussed. A letter was sent home to the parents/carers of all of the students of the classes that had been

identified as participants for the study, explaining its purpose and the ethical considerations (Appendix 12). As overt observations took place where I was visible and known to the students as someone observing them (Cohen et al., 2008), a further consent form was issued for each of the students (Appendix 13), the headteacher, and teachers (Appendices 14 and 15). Any students who indicated that they did not wish to be recorded or interviewed were duly noted and not approached to be part of the data collected using those methods. All data that were collected throughout the study has been managed and stored following the guidance produced by the University of York, with all participants and students remaining anonymous and data to be destroyed on the completion of the study.

3.11 Chapter Summary

In summary, the purpose of this research study was to develop knowledge out of evidence and contribute understanding regarding classroom oral feedback practices by addressing the aim of '*How science teachers conceptualise and practise oral feedback, and how students perceive it helps their learning'*

This chapter has set out to describe, explain and justify the philosophical position underpinning the study and all of the associated aspects of the methodology that flowed out of this standpoint. A qualitative case study design was employed to answer the research question with pertinent methods utilised to gather the data. Information regarding the selection of participants and sites has been provided, along with descriptions of the ten teachers. A critical analysis of the different methods employed by the study has been presented, as well as that of the grounded theory data analysis process and the impact of myself as the researcher on all aspects of the study. The limitations, and processes to mitigate each, have been discussed throughout, in conjunction with approaches undertaken to ensure the trustworthiness of the study. As such, this chapter has set out to specify the methodology and research methods used in this study clearly, in order to immediately address the issue of replicability for anyone wishing to undertake the same study, as well as information regarding the ethical considerations that were reflected upon and addressed.

Consequently, the decisions taken in the methodology have tried to ensure that the findings, which are presented in the next three chapters, are not only trustworthy, but also that they contribute new knowledge to the field, achieve the aim of the research and answer the research questions that this study set out to address.

Chapter 4 Teachers' Conceptualisation

4.1 Introduction

Having proposed a conceptualisation of feedback derived from the literature, this and the following two chapters will present a narrative of the findings presented by this study in relation to it, and other aspects of feedback discussed in Chapter 2. Teachers' conceptualisations of feedback alongside students' perceptions, provide the lens through which teachers' oral interactions in the classrooms will be examined. The data analysis will be presented to address the research questions as follows:

- Chapter 4 – Conceptualisation: How all of the teachers conceptualised feedback and perceived their own classroom feedback practice repertoires.

Addressing research questions:

  - *1. How do science teachers conceptualise feedback and perceive their feedback practices including oral feedback?*
  - *2. What characteristics of oral feedback do science teachers perceive as improving learning?*

- Chapter 5 - Student Perceptions: The characteristics of oral interactions that students perceived helped their learning.

Addressing research question:

  - *3. What types of oral interactions do students perceive as helping learning?*

- Chapter 6 - Classroom Practice: How all of the teachers interacted orally with their students and how this compared to their conceptualisation of feedback and students' perceptions of what helped learning.

Addressing research question

  - *4. To what extent and in what ways do science teachers' oral interactions compare to their conceptualisation of oral feedback and students' perceptions of what helps learning?*

In this chapter the data sources examined to answer research questions 1 and 2 were the initial and final teacher interviews. Interviews were analysed and coded using a constant comparative grounded theory process in order to generate themes, patterns and theory. A total of 19 teacher interviews were conducted with the ten case study science teachers; one of the teachers moved school during the school year and consequently no final interview data were collected.

Emergent themes around teachers' conceptualisation of feedback, and in particular oral feedback, are explored. The following section presents the four themes that emerged from the teacher interviews, where they conceptualised feedback as: (1) a process to improve, with differing foci identified across the teachers. (2) A two-way interaction. (3) Students needing to respond. (4) A way to provoke *dynamic* behaviours in students.

The chapter will then explore the themes related to teachers' perceptions regarding their normal feedback practices. These themes include: (1) feedback interaction preferences; oral versus written, and small group/individual versus whole class communications. (2) Feedback practice repertoires; including the use of questions, mechanisms to assess current understanding, and promoting student-directed learning. How teachers' conceptualisations relate to the derived definition of feedback will be considered throughout. Finally, the characteristics that teachers attribute specifically to oral feedback that they believe improves learning are analysed. Throughout the chapter a number of the different facets of feedback set forth by the teachers are examined alongside learning theories, and the ideal typical theoretical framework propositioned by Torrance and Pryor (2001), with implications considered.

4.2 Teachers' Conceptualisation of Feedback

Ahead of the analysis of teachers' conceptualisation of feedback, it is worth reiterating that the theoretically derived definition of feedback that was proposed in Chapter 2 concluded that feedback is:

> ***Useful information provided from an agent (teacher, peer, book, parent, self or personal experience) which supports learning, relates to learning goals, regarding aspects of one's performance or understanding, and is utilised to improve one's learning of science.***

For the teachers interviewed in the study, in the main their characterisation of feedback was similar to the theoretically constructed definition in Chapter 2. However, differences emerged across the teachers relating to the emphasis of the two-way student-teacher dialogue and teachers' views of student behaviours within the feedback process. The reasons for these differences will be presented,

assimilated to the relevant learning theories and the ideal typical approaches to feedback that were discussed in Chapter 2.

From their initial interviews, the teachers constructed a definition for feedback that was consistent across eight of them. Feedback was linked to students' progress with both teachers and students seen as having a part to play. Teachers perceived feedback not as a unidirectional undertaking, but rather as a two-way relationship, with student actions needed to help them improve. However, the emphasis of the feedback communications, alluding to what it may help to improve, differed across the teachers. Six of the teachers saw feedback as being important in helping to improve student progress in task performance or completing tasks to an appropriate standard, as opposed to the others who saw it as improving learning and understanding. These differences across the teachers may allude to underlying differing beliefs of learning (Agarkar & Brock, 2017; Black & Wiliam, 1998a; Gipps et al., 2000; Hargreaves et al., 2000; Lee, 2009; Hargreaves et al., 2000; Torrance & Pryor, 2001).

The additional characteristic that was identified from some of the teacher interviews, was related to how teachers acted to engender *dynamic* student behaviours, to empower students to generate answers for themselves during feedback. Table 4.1 shows the characteristics of feedback that each teacher identified in their definition. The sections that follow exemplify how these characteristics emerged from teacher interviews. Feedback is complex; both conceptually and pragmatically (Dann, 2018, Hattie, 2008), with no one unified definition agreed in the literature, and this too was the case for the teachers. Although there were common features expressed, no single definition emerged from the teachers, with the differences between individual teachers found to be greater than the differences between schools. In order to preserve anonymity amongst the teachers, the schools to which they were each linked will not be disclosed.

Teacher / Feedback Characteristic	Belle	Charis	Dillon	Eric	Flora	Garry	Henry	Isobel	Jacob	Kris	Totals
A process to improve: task performance	✔	✔			✔	✔		✔		✔	**10**
A process to improve: learning			✔	✔			✔		✔		
Information is acted upon by students	✔	✔	✔	✔	✔	✔	✔			✔	**8**
A two way interaction	✔		✔	✔		✔	✔	✔	✔	✔	**8**
Encouraging *dynamic* student behaviours	✔		✔	✔	✔	✔	✔	✔			**7**
Number/teacher	**4**	**2**	**4**	**4**	**3**	**4**	**4**	**3**	**2**	**3**	

Table 4.1 Distribution of feedback characteristics across teachers

4.2.1 A Process to Improve

All ten teachers discussed how feedback was a process that they utilised primarily to help their students improve. The teachers' conceptualisation of feedback indicated a number of different aspects that could be addressed in order to assist students in making this progress. Constituent aspects of feedback communications that they suggested included:

1. Providing students with information about what had been done well:

> *It means pointing out what's been done well and how you can improve, I think. (Flora, Initial Interview)*

2. Providing students with ideas of how to improve i.e. what actions they may wish to undertake to help them:

> *It's communicating to students either what they have done well so they can continue doing that, or what they could do better so that they could make improvements, some way of looping back to them. (Garry, Initial Interview)*

3. Spotting errors in students' work:

> *It might be you walking around as they're getting on with a piece of work and just saying, 'Oh you've missed a label off that graph', or something like that. (Charis, Initial Interview)*

4. Identifying misunderstandings in the way students are thinking:

> *Ok, feedback for me is looking at an outcome, spotting patterns, checking for misunderstandings and then helping the student to realise what mistakes they have made. (Dillon, Initial Interview)*

Interactions ‘providing students with information about what had been done well’ relate to the *progress* feedback model proposed previously (see section 2.7.2.1), as such communications indicate what a student has achieved i.e. ‘how am I doing so far?’ (Hattie & Timperley, 2007). The *progress* model of feedback (Voerman et al., 2012) has not been cited as often as being as effective in improving students’ learning as its counterpart *discrepancy* feedback (Carnell, 2000; Hattie & Timperley, 2007; Kluger & DeNisi, 1996; Shute, 2007, 2008; Voerman et al., 2012). However, proponents of *progress* feedback (Schunk & Swartz, 1993; Schunk & Ertmer, 1999) claim that it is more influential in improving students’ learning strategies and motivation. With respect to the teachers’ conceptualisation, only two (Flora and Garry) mentioned the *progress* model, and both did so in concurrence with *discrepancy* information, ‘providing students with ideas of how to improve’, i.e. answering the question ‘where to next?’ (Hattie & Timperley, 2007). This is interesting, and also not surprising, as providing both *discrepancy* and *progress* information is a common feedback practice utilised by teachers throughout the country, where two dominant approaches commonly used involve teachers (and often students) providing both *progress* and *discrepancy* information; W.W.W./E.B.I. (what went well/even better if), or alternatively two stars and a wish.

Interactions ‘providing students with ideas of how to improve’, ‘spotting errors’ or ‘identifying misunderstandings’ are all aspects of the *discrepancy* feedback model (Voerman et al., 2012). The teachers’ responses provide insight into the intrinsic makeup of such feedback, indicating how different types of *discrepancy* interactions may “appear” within classroom contexts. All ten teachers cited *discrepancy* information as the feedback model they would use. The notion that *discrepancy* information provided to students was the more dominant model, is concurrent with ideas presented across the analysis of the literature (Hattie & Timperley, 2007; Sadler, 1989; Shute, 2007, 2008; Wiggins, 2012, 2016; Wiliam, 2011), and concurs with the conceptualisation of feedback presented by this study.

Whether students perceived both of these models of feedback as equally beneficial in helping their learning will be discussed later, as will teachers’ perceptions regarding the source of the ‘improvement’ information (see section 4.2.3). Consequently, both *discrepancy* and *progress* oral categories were incorporated into the observation schedule developed by this study, and used to analyse all of the different types of teacher to student oral interactions occurring within teachers’ classrooms.

4.2.1.1 Feedback Improvement Foci - Task Performance or Learning

When asked how they would define feedback, all ten teachers reported that it was an undertaking that should support the student in improving. All ten teachers included the idea that this would be achieved through some communication about what needed to be instigated, i.e. the action that should be implemented by the student as a consequence of engaging in dialogue with the teacher. However, the emphasis of the feedback utilised by the teachers to help the students' improve differed across them, with two distinct groupings being noted. The first of these related to teachers conceptualising feedback as being a process to help students improve their task performance:

> *Feedback has got to be either skills related or content related … and will help you improve on that step first and then this step next and then sort of like that. (Kris, Initial Interview)*

Feedback that conveys messages about improving task performance relates to the lower levels of foci deemed to be less effective in helping learners (Hattie & Timperley, 2007; Kluger & DeNisi, 1996). This view of feedback also reflects previous discussions regarding theories associated with a behaviourist conceptualisation of learning, and how some teachers of science perceive their role in helping students cover the curriculum. In such situations the teacher's agenda takes precedence, informing them of where students are in the coverage of the curriculum (Torrance and Pryor, 2001), and student development is seen as sequential with students progressing through neatly packaged units of skills or knowledge (Buhagiar, 2005; Sadler, 1989). The fact that six out of ten of the teachers perceived feedback in this way concurs with the point made previously that it may be easier for teachers to provide guidance to students in terms of concepts acquired, content mastered, or quality of presentation than it is to discuss the quality of responses or degree of expertise (Sadler, 1989; Vercauteren, 2009). Nevertheless, it is possible that if a task is designed, and evaluated by students and teachers with evidence related to learning considered, there is the possibility that such teachers' views align with constructivist theories and divergent practices.

Conversely, the remaining teachers discussed feedback as a way to help improve students' learning from their current point of understanding:

Feedback to me [is] where I gather information from the children about where they are at in terms of their learning … to help them move forward from where they're at with their learning. (Eric, Initial Interview)

For this subset of teachers, feedback was perceived to be a process to help students improve their understanding as opposed to their ability to perform a task correctly or cover curriculum content. Feedback where the messages focus on developing understanding about learning processes, aligns to the higher levels of foci deemed to be more effective in helping learners (Hattie & Timperley, 2007; Kluger & DeNisi, 1996). As such teachers who perceive feedback in this way ally with constructivist views of learning, in which the teacher operates within the *Zone of Proximal Development* (Vygotsky, 1986) in order to explore and exploit the differences in the understanding of their students (James, 2006; Torrance, 2012) and resonates with ideas regarding effective learning in science (Driver et al., 1994, 2000; Harrison, 2015; Harlen et al., 2015).

This distinction between the study's participants is of interest as teachers' conceptualisations of learning have been shown to affect teachers' perceptions and use of pedagogical approaches including feedback (Black & Wiliam, 1998a; Gipps et al., 2000; Torrance and Pryor, 2001). Nevertheless, teachers tend not to act in alignment with a single theoretical approach but rather use a range of practices in which one theoretical approach might dominate (Niederhauser & Stoddart, 2001). Consequently, whether the six teachers who discussed feedback from a more behaviourist perspective undertake more convergent feedback practices, whilst those who professed a constructivist preference draw on divergent approaches, are aspects that are examined in Chapter 6 in which the classroom practices of all of the teachers are analysed.

4.2.2 A Two-way Process with Students Responding

From the teachers' definitions of what feedback meant to them, it became clear that supporting students to improve was only one aspect of their conceptualisation. There was a large degree of agreement between the teachers that the feedback process needed to be reciprocal, with both teacher and student being active participants. Eight out of ten of the teachers perceived feedback as a two-way interaction, with areas for improvement being identified.

I think of feedback as a two way process where I gather information from the children about where they're at in terms of their learning and then I provide them with information … to help them move forward from where they're at with their learning. (Eric, Initial Interview)

Like a two way kind of process, the teacher gives them some advice and then they improve a piece of work or they answer a question with more detail, something for them. (Belle, Initial Interview)

The other facet of feedback in which there was broad agreement between the teachers was that feedback required the student to be active in the process, with eight out of ten of them discussing how students would subsequently respond and act on the information they were given.

There's no point giving it if you're not expecting some response from it, do you know what I mean? Otherwise you're just saying 'Oh yeah that was just fine' and they won't bother doing anything else with it. Yeah, you're giving them feedback because there's something that you want them to add or to do. (Flora, Initial Interview)

Feedback I think, when I receive it and when I give it, I just I want it to be something that can be acted upon. (Kris, Initial Interview)

The groups of teachers were not identical, Charis and Flora did not mention the interaction as being two ways, and Isobel and Jacob did not discuss students acting as a consequence of the feedback. However, the remaining teachers discussed both aspects concurrently. Even though the teachers describe feedback as a two-way relationship that involves dialogue between them and their students, with students acting on the information, their definition could also be interpreted to indicate a unidirectional process. That is, the teacher indicates to the student what it

is that needs to be acted upon, and subsequently the student responds. Therefore, the feedback interactions that the teachers discuss occurring between themselves and their students has the potential to be utilised in either a constructivist manner, as loops or ping-pong; or in accordance with behaviourist theories, as a gift (Askew & Lodge, 2000). The idea of feedback as either unidirectional or a truly two-way relationship, and whether or not that has any perceived impact on learning, is explored further in this and subsequent chapters.

The characteristics described by teachers of what feedback means to them agrees with the definition synthesised in Chapter 2 and presented in Section 4.2. However, there are some differences too with regards to the teachers' definitions of feedback and that derived from literature. Both definitions include the idea that feedback is utilised to help students improve as part of a two-way dialogue, with students responding. All teachers described a model of feedback based on *discrepancy* information shared, with the students being helped in knowing what they needed to improve. However, for some teachers, the purpose was to improve task performance, whilst others perceived it to be about developing students' understanding and learning.

No teachers' definition explicitly mentioned learning goals or any success criteria associated with them, as a constituent aspect of feedback discussions. The teachers, who did discuss feedback as improving learning, did so from the perspective of students' current understanding, and not in terms of "clarity as to when and how a student would know they were successful" (Hattie & Timperley, 2007, p. 88). From the literature, learning goals are an integral aspect of feedback, and clarity for learners of what the learning goals constitute is vital if feedback is to benefit learning (Brookhart, 2012; Chappuis, 2012; Hattie & Timperley, 2007; Hattie, 2012b; Hattie & Gan, 2017; Wiggins, 1997, 2012, 2016). This lack of reference to learning goals indicates that, for teachers, feedback may be related more to the lower levels of foci associated with self and tasks, rather than the higher levels coupled with interactions exploring learning processes and self-regulation (Hattie & Timperley, 2007; Kluger & DeNisi, 1996; Tunstall & Gipps, 1996). The comparative analysis of teachers' beliefs about feedback alongside their actual classroom practices will be discussed in Chapter 6.

4.2.3 Encouraging *Dynamic* Student Behaviours

As well as differences between the teachers with regards to what they emphasised in feedback discussions, it was evident from the data analysis that for

some teachers, encouraging students to behave in a *dynamic* way, where students are enabled to be cognitively engaged, active and involved in generating evaluative information was a facet of what feedback meant to them. This additional aspect was alluded to in the research synthesis (Blanchard, 2008, 2009; Gipps et al., 2000; Hargreaves, 2012; Sadler, 1989; Torrance, 2012), and related to the roles and behaviours of both teachers and students during feedback (see section 2.8 and 2.9).

A number of the teachers in the study reported that they were there to develop behaviours in students, which, as a consequence of the teacher's support, would shift the locus of responsibility and enable students to identify what they needed to do to improve. From the teachers who discussed helping students generate solutions, their ideas of how this could be achieved was by using divergent approaches to promote student-directed learning, in order that students could work things out for themselves or by pointing them in the direction of supplementary material.

> *Feedback for me is, hopefully getting them to come up with the corrections and the changes in their understanding that leads them to the correct understanding. I do like it when the students have light bulb moments, and a light bulb moment is not me giving them the answer but they come up with the answer themselves, so that is definitely my preferred style. (Dillon, Initial Interview)*

> *I help them get that information from somewhere else, like their friend or somewhere else, about something that's going to help them move forward from where they're at with their learning. (Eric, Initial Interview)*

Supporting students in generating their own answers or next steps, as an additional component of feedback, was not an idea that was advanced by all the teachers (see Table 4.1). The notion that feedback information can be provided from a range of sources, and does not necessarily need to emanate from just the teacher, is connected to the definition of feedback derived from literature, and ideas associated with constructivist learning theories (Hattie & Timperley, 2007; Shute,

2007, 2008; Voerman et al., 2014; Vygotsky, 1978). Sadler (1989) made a distinction between feedback and self-monitoring in terms of the source of the evaluative information, in which he argued that if the learner generated the relevant information, the procedure is part of self-monitoring. If, however, the source of information is external to the learner, it is associated with feedback. However, other researchers have argued the importance of self-regulation and students functioning as direct as sources of information in feedback (Hattie & Timperley, 2007; Nicol & Macfarlane-Dick, 2006).

Intriguingly, here we have some teachers who in their definition of feedback see themselves supporting students to generate the relevant information by shifting the locus of control from the teacher to the learner so they are cognitively engaged; this is consistent with other studies on feedback (Askew & Lodge, 2000; Carnell, 2000; Dann, 2015a; Gipps et al., 2000; Hargreaves, 2012, 2013, 2014; Plank, Dixon & Ward, 2014). Such promotion of student-directed learning has the potential to enable students to operate as *dynamic* co-agents in the process, which is advantageous for their learning (Blanchard, 2008, 2009; Dann, 2015a; Hargreaves, 2012; Sadler, 1989, Vercauteren, 2009; Voerman et al., 2014). A view that accords with findings from other studies utilising a divergent approach to feedback linked to constructivist theories (Hattie & Timperley, 2007; Murtagh, 2014; Sadler, 2010; Torrance, 2012; Vercauteren, 2009). It may be that for the sub-set of teachers who did not discuss the behaviours that they wished to develop in students as part of feedback was an oversight rather than an omission. This could be in part due to the semi-structured nature of the interview and the open questions asked. Therefore, it will be of value to ensure that this facet of the conceptualised nature of feedback is monitored for all teachers during the analysis of their classroom practice.

In summary, from the analysis of the teacher interviews all teachers saw feedback as a process to help students improve. Eight out of ten of the teachers saw feedback as a two way process, and a different group of eight of the ten suggested students were active and acting on information provided. However, how teachers perceived the importance of students' behaviours varied. Seven teachers perceived that feedback involved the teacher promoting student-directed learning to empower students to operating as *dynamic* agents in the process. It was of no surprise that teachers' definitions had characteristics in common with that derived from the literature. Schools at the moment are expending large amounts of time and effort into feedback processes linked to marking (Department for Education, 2016a; Elliott et al., 2016). Approaches such as "'triple impact marking' (whereby teachers

provide a written response to student responses), and 'dialogic marking' (in which a written 'conversation' is developed over time between teachers and students)" (Elliott et al., 2016, p. 17) are widely employed practices, and do involve educators engaging in all of the aspects advanced by the study's teachers.

Interestingly, what were not evident from the data collected from the teachers were discussions regarding the learning goal or success criteria related to it. This may be related to the broad gamut of pressures under which teachers in the UK currently find themselves operating (Eyers & Hill, 2004; Hargreaves, 2012). Again, this does not mean that teachers did not see it as unimportant, only that they did not mention it explicitly in interviews. However, it is worth considering when analysing students' perceptions and teachers' classroom practice.

In short, the teachers' conceptualisations from their synthesised responses leads to a definition of feedback that includes:

- A process to support improvement either task performance or learning. This includes *discrepancy* information, which involves providing ideas of what needs to be done to improve and/or emphasising errors or misunderstandings; and maybe *progress* information.
- A two-way relationship between the teacher and the student where both are active.
- Students acting on the information provided.
- Encouraging *dynamic* student behaviours – this entails teachers enabling students to take responsibility, and be active in generating evaluative information or next steps in the process.

Figure 4.1 illustrates how all of the teachers conceptualised feedback and how the associated feedback characteristics were distributed across each of them.

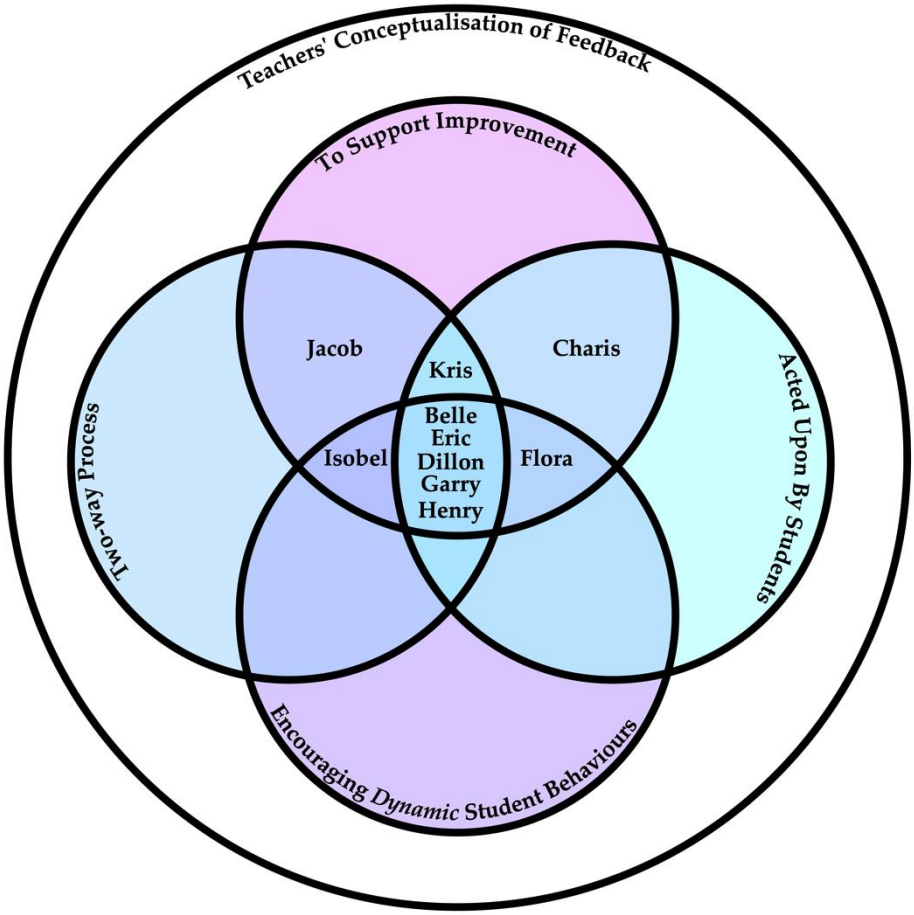


Figure 4.1 Teachers' conceptualisation of feedback

Interestingly, Charis, Flora, Isobel and Jacob provided more limited definitions of feedback, in which they identified only a small number of characteristics. If teachers had been provided with a definition of feedback that included all of the different features defined above, they might all have contended that each were part of their conceptualisation of feedback; or at least have been able to discuss why they did not wish to add them to their conceptualisation. However, as the characteristics and conceptualised definition of feedback have been synthesised from the teachers' explanations, it cannot be assumed that just because teachers did not mention some aspects that they do not believe these to be important features of feedback, or indeed that they did not enact some or all of these strategies in their teaching. An advantage of not providing a list of pre-determined characteristics or a definition for feedback to the teachers was that it allowed teachers the opportunity to reflect on and share their ideas, and to explore their core perceptions and dominant views, rather than discussing those from someone else.

In order to mitigate for this, it will be important to compare all of the teachers against all of the various facets of feedback identified when analysing the data from their classroom practices and to link this analysis to students' perceptions of what helps their learning. This links to the grounded theory approach previously discussed (O'Connor et al., 2008), that when utilising constant comparison all data are systematically compared to all other data in the data set. Therefore no data can be ignored or not considered. This assures that all data produced are analysed rather than potentially disregarded on thematic grounds. The use of all categories to analyse all teachers' practice also allows for the same analytical framework to be used by other researchers, increasing the trustworthiness of the study. Furthermore, comparisons of how each individual teacher's definitions of feedback linked to their classroom practice of feedback, along with their conceptualisation of student behaviours, will be explored more in Chapter 6.

4.3 Teachers' Perceptions of Their Normal Feedback Practices

The next section analyses how the teachers perceived their generic feedback practices. The teachers identified a range of different characteristics linked to what they described as their perceived normal feedback practices. These discussions were not linked specifically to either written or oral feedback. However, the main feedback approach that each teacher described when deliberating generic feedback practices will be highlighted, along with their preferences for how they interact with their students. The feedback practice repertoires the teachers identified that they employed during such feedback interactions are then examined. Following this analysis, Section 4.4 will explore in detail teachers' conceptualisations pertaining explicitly to oral feedback that they believes helps learning.

4.3.1 Feedback Interaction Preferences

When asked the question *'How would you describe your normal feedback practices?'* which was purposefully left open to allow teachers to express all aspects of their feedback practices, teachers' responses indicated preferences for how they interacted with their students. The following two sections examine teachers' preferences in terms of the mode of the feedback interaction - written and/or oral, and the situation of the feedback interaction – whole class and/or small groups/individual communications.

4.3.1.1 Written Versus Oral

A summary of all of the teachers' responses regarding their perceived preferred mode for feedback interactions can be seen in Table 4.2. Only six of the

teachers spoke about both modes of communicating feedback with their students, with six out of the ten teachers preferring oral interactions and two written. Of the teachers who described both modes of their feedback practices, oral and written, only Belle and Isobel did not indicate that they had a preferred feedback method that they utilised more when engaging with their students.

Feedback Approach Discussed / Teacher	Oral	Written	No Preference Indicated
Belle	✔	✔	✔*
Charis		✔*	
Dillon	✔*		
Eric	✔*		
Flora	✔*	✔	
Garry	✔*	✔	
Henry	✔*	✔	
Isobel	✔	✔	✔*
Jacob	✔*		
Kris	✔	✔*	
Totals	**6**	**2**	**2**

Table 4.2 Feedback communication mode discussed
(Ticks with an asterisk * next to them indicate teachers' perceived preferred feedback approach)

Examples of responses from the two teachers who predominantly discussed written feedback as their preferred method include:

> *I try to give feedback in the lesson but that's often more generalised … but written feedback is where I really get to know my students better I think (Kris, Initial Interview).*

I do really like the DIRT [Dedicated Improvement and Reflection Time, a strategy for structuring dialogue marking] time we call it, cos like I said I do think that is really valuable (Charis, Initial Interview),

On the other hand, the teachers who principally discussed oral feedback practices as their preferred feedback mode included responses such as:

The preferred style I use is … to develop their understanding through the dialogue (Dillon, Initial Interview).

So my normal feedback practice is that I do try and give the kids as much oral feedback as I can and I try and place as much emphasis on gathering information from them as I can (Eric, Initial Interview).

Exploration of teachers' written feedback lies outside the scope of this study. However, the reasons advanced from the teachers who preferred this approach to oral feedback were due to them seeing it as a preferred way to build relationships, or because they had not considered oral feedback previously.

I do like marking books and seeing that relationship develop with students and I think it's about developing relationships (Kris, Initial Interview).

It's something that I've not really thought about until this study. I know I will be giving oral feedback all the time, so I hope that I'm giving some valid feedback every lesson but it has made me wonder (Charis, Initial Interview).

Teachers' preferences aligned to oral feedback replicates previous findings (Gipps et al., 2000; Hargreaves, 2011; Weeden & Winter, 1999; Weeden, et al.,

2002), and affiliates with students' preference for oral feedback (Weeden & Winter, 1999; Weeden, et al., 2002; Williams, 2010). Detailed analysis of how the teachers perceived their practice associated with oral feedback will be examined later in this chapter, along with a detailed examination of what their actual oral feedback practices were in Chapter 6.

4.3.1.2 Small Group/Individual Versus Whole Class

The aspect of providing feedback that the teachers commented on most frequently was linked to how they perceived that they were able to facilitate it with their students. The teachers' preferred method of providing oral feedback to students was either in a one-to-one interaction, or with a small group, with nine out of the ten teachers expressing this was how they engaged in oral feedback. As one explained:

> *I try to give feedback in the lesson, one to one if I can (Kris, Initial Interview*).

Teachers also discussed how interactions with smaller numbers of students had the benefit of building relationships with students.

> *You're registering to them, you know, 'I value the importance of your understanding and I'm going to engage with you as a person to help you move forward'. So I think there's a lot there about relationships as well (Eric, Initial Interview).*

In addition, whilst discussing providing oral feedback through interactions with smaller numbers of students, teachers described how they hoped they were managing to talk to every student in the class.

> *Obviously I like to think that I'm speaking to every student every lesson (Charis, Initial Interview).*

Constantly, and you do your best to try and touch upon everybody as well, you know (Flora, Initial Interview).

Alongside this, the main barrier perceived by teachers in their utilisation of oral feedback was not being able to interact with all students during a lesson, with eight out of the ten teachers citing this as their main concern. Consequently, teachers discussed how they adapted their practice so that they focused on providing oral feedback to students whom they identified as needing their additional support.

I do attempt to get round, I'd say every single student between every two to three lessons. Some students get more than others though. (Isobel, Initial Interview)

I think, well, I give feedback every lesson but I don't think I could have enough time to see everyone in the class if I was giving personalised feedback to everyone, so it's usually the people who are struggling or are confident enough to ask, or they're interested enough to ask, are the ones I give oral feedback to. (Belle, Initial Interview)

In contrast to the teachers who identified interacting with smaller groups of students, only four (Belle, Charis, Isobel and Jacob) mentioned that they would undertake oral feedback with the whole class. From their descriptions, these oral feedback interactions entailed them using questioning with the whole class.

Using the hands up approach, that tends to be one of my fall backs, of going, ok, like 'Hands up what do you think about?' … but generally your quality of feedback from that is fairly poor, depending on the class and how they're feeling, you can get anywhere between everyone having a go and or the entire class sitting there completely stone faced. (Jacob, Initial Interview)

Just generally using questions as a whole class, and just quick feedback as a kind of whole class questioning. Drawing out answers usually by like random questioning. (Belle, Initial Interview)

This highlights an interesting perception from the teachers that oral feedback is seen in the main as a mechanism for supporting learners in individual or small group interactions, as well as potentially taking some considerable time to facilitate. This concurs with Black's (2010) point regarding teachers' failure to properly grasp the concept of AfL, including the use of feedback, with discussions about learning not being seen as integral to all communications undertaken within classrooms. Another aspect, therefore, of the analysis of the utilisation of oral feedback was to determine how teachers interacted with their students, and whether 'common oral practices' that were perceived to be beneficial could be facilitated with not only small groups and individuals but also during whole-class interactions (see section 6.3.1). This is important, as the effective use of oral feedback has implications for policy makers, practitioners and educators alike, in maximising learning opportunities through oral feedback interactions at various points within lessons.

4.3.3 Feedback Practice Repertoires

In addition to providing students with *discrepancy* information, analysis of teachers' accounts when responding to the question *'How would they describe their normal feedback practices?*' gave rise to three further teaching practices that the teachers perceived would be manifest as part of their feedback repertoire. These different practices are listed, with the number of teachers who cited each facet indicated in brackets: (A) asking the students questions (9). (B) Assessing current levels of understanding (6). (C) Promoting student-directed learning; in particular, by not giving them answers (5). In order to provide additional insights into the characteristics ascribed by the teachers for each of the strategies, further exemplification is given below.

4.3.3.1 Asking Students Questions

Asking students questions was the most cited feedback practice propositioned by the teachers. In fact, Charis was the only teacher not to identify this as a way they implemented feedback practices.

Feedback very often is a question (Eric, Initial Interview).

The uses of questions in feedback were twofold: to help teachers ascertain students' thinking, and to direct students to the next steps and the actions they needed to instigate.

Oral feedback's a lot more questions about understanding in lessons … I think that way I can then feedback to them and they can then actually try and improve it and then try again (Isobel, Initial Interview).

[How would you describe your feedback practices?] Why I think questioning. Yeah if you go and look at someone's work and it's looking shocking, how do you think you can make that look a little bit better? You know, have you included this? Did you remember to make sure that? You know, those sorts of questions so they can look at it and now think 'Oh yeah that's not right or that bit's not there' or things like that really (Flora, Initial Interview).

As discussed in section 2.8.2 there has been some disagreement as to whether questions can be considered a mechanism used during feedback, with a number of studies alluding to the beneficial use of them (Brookhart, 2012; Dann, 2018; Elliott et al., 2016; Gipps et al., 2000; Hargreaves, 2013, 2014; Torrance & Pryor, 2001), whilst others claim they are more a type of instruction than feedback (Knight, 2003; Voerman et al., 2012). However, utilising divergent open questions (Torrance and Pryor, 2001) has the potential to support students in constructing meaning as part of feedback. As such, they could be considered one manifestation of feedback practices seen in the classroom. Whether or not teachers' questioning practices align to divergent constructivist approaches, and were perceived as beneficial for learning by the students, are aspects of the findings that will be explored further in subsequent chapters.

4.3.3.2 Assessing Current Understanding

Additional teaching strategies, apart from asking questions, that teachers expressed that they employed when implementing feedback, became evident as

ways in which the teachers ascertained feedback *from* the students regarding current understanding. These included approaches such as:

1. Formal planned class activities:

    - Whole class response systems:

    I've got a few things for getting feedback, I've got the mini whiteboards, I've got some little coloured cards in sets that are red, green, yellow with true, false and nobody knows on one side and ABC on the other and they're about hand size…so that's where we're actually polling everybody [about] what are you thinking (Jacob, Initial Interview).

    - Activities at the start of the lesson:

    At the beginning of a lesson [I] do some work and check on understanding. (Isobel, Initial Interview)

    - Activities at the end of the lesson such as the plenaries:

    It might just be like your plenary that you do at the end … various ways but just checking and getting a feel that they've understood what the point of the lesson was … I would make a note in my planner if I felt that they'd not done it and then we'd go over it next lesson (Charis, Initial Interview).

2. Informal discussions with students:

    - Instigating conversations throughout the lesson, that are not limited to asking questions.

    The vast majority for me [of feedback] is a lot of talking, discussion, not talking at them but having a conversation with them during the lesson. You know every now and then, you know if I'm going round the classroom they know they can ask me questions pretty much on anything, but I do try and generally have it related to stuff and assessing how they're thinking about things, and to check that they are actually thinking about it rather than just passively taking in this information (Henry, Initial Interview).

If they are only used to establish the student's current levels of understanding, then whole class response systems, starters, plenaries and classroom dialogue *per se* do not necessarily form part of an oral feedback approach between the teacher to the student aligned to the definition derived and used in this study. That is, if no useful information is provided to the student related to the learning goals, which as a consequence is then utilised by them, or which they find helpful for their learning, then for this study such interactions would not be classed as feedback. In fact, such teaching approaches are more likely to operate as feedback mechanisms for the teacher, as they enable them to ascertain useful information from their students on which they can respond.

Such teaching approaches do, however, align to practices with a particular cogency with learning in science, especially when they are utilised to identify areas in which students may harbour alternative ideas or misunderstandings (Driver et al., 1994; Driver et al., 2000). Therefore, the fact that teachers reference these strategies as approaches that they employ during classroom interactions is not surprising. Nonetheless, what are of more importance for this study are the oral interactions that occur at these points in the teaching sequence of a lesson. Consequently, analysis of the language used as part of these oral interactions was reviewed in order to ascertain which, if any, characteristics were perceived to help students' learning. Therefore, providing clarity as to what constitutes feedback during such oral interactions aligned to the conceptualisation set forth by this study.

4.3.3.3 Promoting Student-directed Learning

When describing their generic feedback practices, half of the teachers discussed how they wanted to promote student-directed learning so that students would be able to generate their own solutions. Belle and Dillon likened supporting students in this way, as assisting them in the manner of a coach/guide, so that they could generate their own solutions.

> *I would say [feedback is] interactive, it's a coaching style, particularly with the groups I teach. It's not, 'I've got all the knowledge and you're the empty vessel'. The model I tend to use is the coaching model and get the students to come up with the answers themselves eventually (Dillon, Initial Interview).*

But guiding them through to, kind of, come up with an answer themselves (Belle, Initial Interview).

On the other hand, Eric, Flora and Garry all talked about how they wanted to empower the students by creating a context so that the students would be creating their own feedback, without necessarily even knowing they had.

In some ways I'm not giving him feedback because I'm not really telling him anything, but at the same time you're creating a context in which he is actually getting feedback, it's just he's doing it himself as he's going through (Eric, Initial Interview).

I get them to think about it so they kind of create their own feedback in a way, I just give them a nudge in the right direction (Garry, Initial Interview).

Interestingly, all of the teachers who advocated that their perceived feedback practices included promoting self-directed learning by supporting the students to generate their own solutions specified that during feedback they would not be giving answers to the students.

Asking them where they think they are, where they should be, yeah, just not giving them the answer, [that] is not helping anyone (Belle, Initial Interview).

Which winds some of them up, 'cos they just want the answer, but I find you are more likely to see that eureka moment where they go "Oh yeah!' I mean, I don't suppose it's feedback as such but sometimes the A level kids ask me a question and I just say I don't know. I don't know whether that's feedback in the sense you're sort of saying you should be able to find it out for yourself, or I'm not going to give you the answer to that (Garry, Initial Interview).

Supporting students to engage in self-directed learning, either by not giving answers or by encouraging them to generate their own solutions, can be seen as way to help learners develop self-monitoring strategies, approaches to feedback seen as powerful for the learner (Gipps et al., 2000; Hargreaves, 2011). Hargreaves (2014) discussed how from her research, feedback in which students were provoked to consider concepts independently seemed to have the most potential for advancing students' self-autonomy, with such practices would be affiliated with divergent approaches to feedback and constructivist teaching practices (Torrance & Pryor, 2001). Consequently, teachers may provoke students to generate their own solutions, or not give students answers, as manifestations of oral feedback strategies designed to help promote *dynamic* student behaviours, therefore increasing their autonomy. It was therefore important to measure the number of interactions in which teachers promoted student-directed learning by provoking students to consider concepts independently, or conversely when they directly provided answers to the students. This was synthesised against students' perceptions of what supported their learning to qualify or challenge ideas discussed related to teachers' feedback practices considered in Chapter 2.

In summary, Figure 4.2 illustrates each individual teacher's perceived feedback practice repertoire.

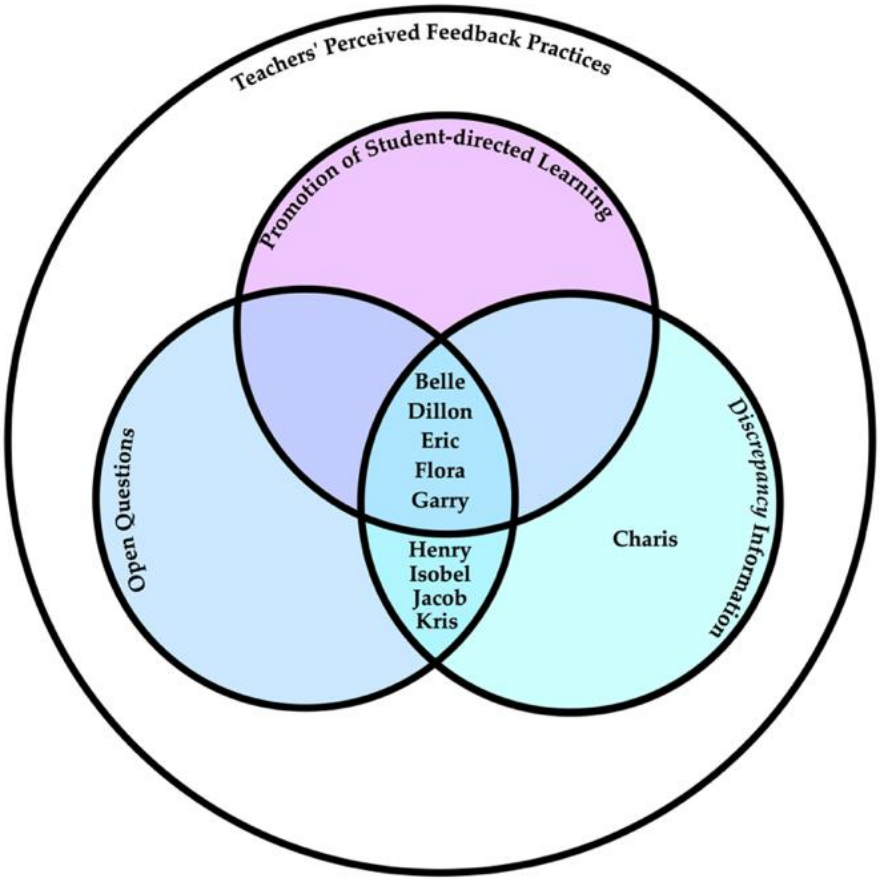


Figure 4.2 Teachers' perceived feedback practices

There were again two distinct groups of teachers who perceived their practices differently when it came to how they believed they operated whilst facilitating feedback, each of which can be affiliated with the two ideal approaches theorised by Torrance and Pryor (2001). One group - Belle; Dillon; Eric; Flora and Garry - perceived that they operated to promote students in self-directed learning to generate their own solutions, in particular by not giving answers, suggesting a tendency towards constructivist pedagogies and divergent practices. Whilst the other group - Henry; Isobel; Jacob; Kris and Charis - made no mention of empowering students in generating the next steps, intimating a tendency towards behaviourist pedagogies and convergent practices. The teachers who discussed supporting students, both as part of their definition and perceived feedback practice repertoire, were Belle, Dillon, Eric, Flora and Garry, whilst Henry and Isobel discussed it as part of their definition and not with regards to their practice.

Again, if the teachers had been presented with all of these facets, they may have maintained that there were more aspects that they believed that they undertook than those presented here, so again it was imperative that all teachers' oral feedback interactions were analysed against all of the feedback types in order

to concur or challenge the perceptions represented here. The next section of this chapter will analyse teachers' views pertaining to oral feedback and the characteristics they believe are specifically associated with its use.

4.4 Characteristics of Oral Feedback Perceived to Improve Learning

After being asked about their general feedback practices, teachers then discussed a number of different characteristics linked solely to oral feedback, which they perceived were beneficial in improving students' learning. From these discussions a number of additional approaches were highlighted, which relate to teachers providing feedback that is accessible to the students, and replicate previous findings.

4.4.1 Immediacy

A beneficial characteristic associated with oral feedback that was reported by eight of the teachers was its immediacy, i.e. it was not at a distance, but rather it occurred during the lesson. For these teachers, oral feedback that was given during the lesson could lead to immediate action. This was seen as being one of the greatest advantages of oral as opposed to written feedback.

> *Oral feedback is very immediate and it's less threatening because it's just fashioning the flow of the lesson generally, and I think it helps people to develop as their doing something, rather than to do it incorrectly or to fail at something or perceive themselves as failing and then have to redo it (Eric, Initial Interview).*

> *[I mostly try] to get them to think about what they're actually doing and I think that's something you can't do with written feedback because you've got no direct interaction with them. Whereas you're talking with someone you can sort of push them in the direction of getting it right (Jacob, Initial Interview).*

Charis clarified how feedback during the lesson was also powerful as it could help the teacher in identifying misconceptions.

Yeah, preventing misconceptions is a big thing. So if you're not giving opportunity for them to talk to you, you could just blunder on without realising that they've completely got the wrong end of the stick. (Charis, Initial Interview)

Garry explained that another advantage of oral feedback was that teachers could see whether or not the students understood what was being discussed and consequently respond and adapt their feedback.

With written, if you're not quite clear, initially they'll go away, spend ages worrying about it, and then come back and then ask you the question, and then you have to explain it more anyway but [oral feedback] you are doing it in class verbally and you can build on it there and then. (Garry, Initial Interview)

It is evident that the teachers valued oral feedback as a learning mechanism and saw that being able to provide it face-to-face whilst the students were with them in the classroom, so that both they and the students could act on evidence being elicited, was advantageous, agreeing with previous findings (Hebert & Voraurer, 2012). Alongside this was the additional benefit that it could be tailored to suit the individual in order that they understood the feedback message, aligning with the idea of 'effective' feedback associated with interactions that are appropriate to the individual (Poulos & Mahony, 2008). Teachers' perceptions regarding the benefits of providing feedback during lessons, concurs with the evidence from others (Chappuis, 2012; Kulik and Kulik, 1988; Elliott et al. 2016), who discuss the cogency of feedback related to its immediacy and adds clarity to the argument proposed by Shute (2007, 2008) propositioned in Chapter 2.

4.4.2 Personalised to the Individual

The final characteristic of oral feedback that was deemed to be important by the teachers was that it could be personalised to the student with whom they were talking. As Dillon discussed, he would give oral feedback to his students differently as he has built up relationships with them, and he knows what works best for the individual students whom he teaches:

The young lady over there is easily destabilised if she gets something wrong. She's bright, she's fantastic, she knows it, but even if, sometimes I won't give them an answer I'll just look quizzical and that doesn't work with her. Because she thinks as soon as you look quizzical at her, she thinks she's got it wrong, whereas the two girls here, if I look at them and go 'Are you sure? Convince me', it works for them and doesn't work for the other young lady at all … knowing the students and knowing what they're comfortable with and what you can do and can't do. (Dillon, Initial Interview)

Kris described how the feedback needed not only to be personalised, and hence specific, for the student, but that it needed to be positive:

Well again I think that really has to be more positive but it can't be just general positive; it's got to be specific positive … as long as you're specific about it. (Kris, Initial Interview)

Garry explained that through providing personalised oral feedback, teachers were able to differentiate it for the students, and respond in order to help them take it on board:

Yeah I guess with oral feedback, I think I can pose more complicated questions initially and then bring it down a little bit. I guess [with] written feedback, you kind of you need to make sure they get it. Yeah, you differentiate it a lot more. (Garry, Initial Interview)

Teachers providing feedback that is accessible to the learner, be that through the building of relationships, providing specific, positive and personalised information, corresponds to ideas raised previously by others (Hebert & Vorauer, 2002; Holmes & Smith, 2003; Orsmond et al., 2005; Poulos and Mahony, 2008; Riccomini, 2002; Shute, 2007, 2008, see section 2.8.1.). However, again missing

from the teachers' descriptions of their perceived feedback practices is whether or not their guidance on how to improve is linked to learning goals, associated with addressing the questions 'What am I going to learn? or "What does good look like?' (Hattie & Timperley, 2007). Discussions regarding learning goals were previously highlighted as vital if feedback is to benefit the learner (Chappuis, 2012; Orsmond et al., 2005; Sadler, 1989; Wiggins, 2012, 2016), and the lack of reference to it may be linked to teachers' beliefs of learning (Agarkar & Brock, 2017; Black & Wiliam, 1998a, 1998b; Gipps et al., 2000; Hargreaves et al., 2000; Torrance & Pryor, 2001).

The examination of how each individual teacher perceived that they utilised feedback alongside the comparative analysis of their feedback definition will be drawn on in Chapter 6, when it will be contrasted with the actual oral interactions that were observed. This comparative analysis will help ascertain how teachers' practices matched, or conflicted with, their perceptions and what, if any, impact their feedback practices had on the perceived learning of students.

4.5 Chapter Summary

4.5.1 Research Question 1

In addressing research question *1 'How do science teachers conceptualise feedback and perceive their feedback practices including oral feedback?',* this study has defined how the teachers conceptualised feedback, and compared it to that theorised from the literature.

The definition of feedback advanced by teachers is:

- A process to support improvement of either task performance or learning. This includes providing: *discrepancy* information*,* which involves ideas of what needs to be done to improve, and/or emphasising errors or misunderstandings, and may include *progress* information;
- A two-way relationship between the teacher and the student in which both are active agents;
- Students acting on the information to improve;
- Encouraging *dynamic* student behaviours – this entails teachers enabling students to take responsibility, and be active in generating evaluative information or next steps in the process.

All of the above aspects of the teachers' definitions align to the conceptualisation of feedback presented by this study. The various foci ascribed to feedback messages (improving task performance or learning), described by differing groups of teachers replicate findings previously ascertained in different settings, contexts and reviews (Black & Wiliam, 1998b; Costa & Garmston, 2017; Dann, 2018; Gipps et al., 2000; Hargreaves, 2011; Plank et al., 2014; Shute, 2007, 2008; Torrance & Pryor, 2001; Voerman et al., 2014). The higher level foci, attributed to developing understanding about learning process and self-regulation are described as more effective in helping learners (Hattie & Timperley, 2007; Kluger & DeNisi, 1996). Teachers' who perceive feedback at these higher foci levels ally with constructivist views of learning, in which the teacher operates within the *Zone of Proximal Development* (Vygotsky, 1986), and resonates with ideas regarding effective learning in science (Driver et al., 1994, 2000; Harrison, 2015; Harlen et al., 2015).

Nevertheless, the teachers' description differed significantly to the theorised conceptualisation of feedback in one respect; namely, the inclusion within feedback of discussions related to the learning goal and success attributed to it. There are many in the field who argue that learning goals are a vital facet of any interaction that is to be classed as feedback (Askew & Lodge, 2000; Black et al., 2002; Brookhart, 2012, Chappuis, 2012; Hattie & Timperley, 2007; Hattie, 2012b; Hattie & Gan, 2017; Orsmond et al., 2005; Sadler, 1989; Voerman et al., 2014; Wiggins, 1997, 2012, 2106), hence the inclusion of this aspect in the theorised definition. The teachers' lack of reference to learning goals or the quality of success attributed to them may be linked to teachers' beliefs of learning (Agarkar & Brock, 2017; Black & Wiliam, 1998a, 1998b; Gipps et al., 2000; Hargreaves et al., 2000; Torrance & Pryor, 2001). However, this may in part be due to the predominance of feedback practices within the current English education system that involve teachers providing *progress* and *discrepancy* information as; W. W. W. /E.B.I. or two stars and a wish. Such practices explicitly involve parties reviewing progress or noting action to undertake to improve, but do not explicitly discuss learning goals or what quality would be with respect to them. Current practices therefore appear to encourage teachers to address the feedback dimensions of 'How am I doing so far?' and 'What should I do to improve?' (Hattie & Timperley, 2007), but seem to be lacking with respect to addressing the questions related to 'what am I going to learn? or 'what does "good" look like?' (see Figure 2.3). This corroborates the notion that it is easier for teachers to provide guidance to students in terms of concepts

acquired, content mastered, or quality of presentation than it is to discuss the quality of responses or degree of expertise (Sadler, 1989; Vercauteren, 2009).

Two distinct groups were observed related to both, teachers' perceptions of what feedback was helping to improve, along with teachers' conceptualisation of student behaviours in the feedback process. Subsets of the teachers were identified as: seeing themselves as empowering students to become autonomous, by supporting them to act as *dynamic* agents in the feedback process; and promoting student directed learning. In each case the remaining teachers did not mention these aspects. Both of these perspectives were linked to underlying learning theories and related divergent/convergent practices. These differing approaches, ascribed to the foci and utilisation of feedback within the classroom and how this may be aligned to teachers' underlying views of learning have been identified previously (Agarkar & Brock, 2017; Black & Wiliam, 1998a; Carnell, 2000; Dann, 2018; Gipps et al., 2000; Hargreaves, 2012, 2013, 2014; Hargreaves et al., 2000; Torrance, 2012; Torrance & Pryor, 2001; Vercauteren, 2009; Voerman et al., 2014;). Nevertheless, a note of caution is due here since teachers' practices tend to to be multi-faceted drawing on a range of approaches. However, there is the potential for one theoretical assumption to dominate their beliefs and behaviours (Niederhauser & Stoddart, 2001). In the analysis in Chapter 5 and 6, students' ideas related to their role as either *dynamic* or *passive* agents in the feedback process will be expounded upon further, with additional findings building on the analysis of data presented here and ideas synthesised in the literature review.

Teacher interaction preferences linked to oral or written feedback and whole class or small group practices were also examined, with teachers' predilections being in the main linked to oral feedback (a view recognised previously by Gipps et al., 2000), and working with students in small groups, rather than as a whole class when providing it. Aspects of how the teachers perceived their own feedback practices were presented, with the use of predominantly *discrepancy* and, to a lesser extent, *progress* information as part of the feedback repertoire, and an additional number of different teaching strategies were identified, namely: (1) Asking the students questions. (2) Assessing current levels of understanding. (3) Promoting student-directed learning, in particular, by not giving them answers. All of which are aspects of feedback practices and approaches to teaching science that have been acknowledged as supporting learning previously (Brookhart, 2012; Dann, 2018; Driver et al., 1994; Driver et al., 2000; Elliott et al., 2016; Gipps et al., 2000; Hargreaves, 2011, 2012, 2013, 2014; Torrance & Pryor, 2001), even though the

efficacy of questions as a mechanism for feedback has been debated (Knight, 2003; Voerman et al., 2012).

4.5.2 Research Question 2

In answering research question 2 '*what characteristics of oral feedback do science teachers perceive as improving learning?',* teachers indicated that their preference for oral feedback was due to the immediacy of the interactions occurring during the learning, affording them a greater opportunity to be responsive to the needs of students and more able to personalise the feedback to benefit students' learning; all of these aspects are aligned to previous findings (Elliott et al., 2016; Hebert & Vorauer, 2002; Holmes & Smith, 2003; Kulik & Kulik, 1998; Orsmond et al., 2005; Poulos and Mahony, 2008; Riccomini, 2002; Shute, 2007, 2008).

It was again noted from teachers' conceptualisations related to their oral feedback practices that there was no specific mention of whether or not their guidance on how to improve was linked to learning goals, i.e. 'What am I going to learn? or "What does good look like?' (Hattie & Timperley, 2007). It has been demonstrated previously that there can exist a disparity between teachers' perceptions and their practices (Chin, 2006; Gamlem & Munthe, 2014; Knight, 2003; Murtagh, 2014; Ruiz-Primo & Li, 2013; Vercauteren, 2009). Whether or not there is alignment between teachers' perceptions and their actual classroom practice will be explored in the comparative analysis discussed in Chapter 6.

In summary, in addressing research questions 1 and 2, the analysis of science teachers' feedback perceptions has contributed to understanding in the field by qualifying previous findings related to: (1) The purpose of feedback as mechanism in supporting learners to improve, in particular providing *discrepancy* information, with differing foci for the feedback interactions being presented linked to task performance or learning. This was perceived in the main, to be two way with students subsequently taking action. (2) Differing interpretations of both teachers' and students' roles within feedback, aligned to two ideal typical approaches, divergent and convergent, and the underpinning learning theories. (3) Classroom strategies that teachers use as part of their feedback practice repertoires, including asking questions and promoting student-directed learning. (4) Teachers' preferences for feedback to be provided orally and with small groups or individuals, with the opportunity to interact with every student perceived as the main barrier.

The next chapter addresses research question 3 and examines students' perspectives regarding aspects of the lessons that they perceived benefitted their

learning. The analysis will highlight a number of different oral interactions that will be classed as oral feedback, along with a variety of sources of useful information that students perceived helped them learn. Finally, a comparison between teachers' conceptualisations of their feedback practices against students' perceptions will be presented. A summary of the different types of oral interactions generated from the analysis of teachers' conceptualisations, subsequently incorporated into the data analysis framework to ground the examination of teachers' classroom practice in the data, is seen in Table 4.3.

Oral Interactions Identified from Teachers' Conceptualisation	**Corresponding Section of Lesson Recording Analytical Framework**
Interactions that involve identifying what needs to be done to improve performance/learning and/or emphasising errors or misunderstandings	Teacher provides ***discrepancy*** information, i.e. how to improve in relation to goal, identifies errors and/or misunderstandings to correct.
Acknowledging what has been done well.	Teacher provides ***progress*** information, i.e. information about what has been done well in relation to goal
Promoting student-directed learning	Teacher promotes **student-directed learning,** i.e. provokes students to generate own solutions on own or with peers
Not giving answers to the students	Teacher provides **answer/direct teaching** of science
Asking the students questions.	Teacher questions: **closed** and **open** types were analysed.
Whole class interactions	Field notes used alongside recordings to note on data analysis tool when teacher was talking to whole class
Small group/individual interactions	Field notes used alongside recordings to note on data analysis tool when teacher was talking to small groups/ individuals

Table 4.3 Influence of teachers' conceptualisation on analytical framework

Further oral types were added to the data analysis framework tool as a consequence of the investigation into students' perceptions regarding which oral interactions helped their learning, as well as from field notes taken during lesson observations. These additional types will be introduced during the relevant discussion in Chapters 5.

Chapter 5 Students' Perceptions

5.1 Introduction

In this chapter research question 3 *'What types of oral interactions do students perceive as helping learning?'* will be answered drawing on the post-lesson interviews conducted with students. The chapter outlines the main categories proposed by students when questioned about what had helped their learning during the science lesson that had immediately preceded the interview. These categories will be analysed against the research literature on learning and feedback to establish similarities and differences within the case study students' responses as to factors they perceived helped their learning. As with the previous chapter, the themes were generated using a constant comparative grounded theory process.

In order to position the analysis of students' perceptions the conceptualisation of feedback theorised by this study is again reiterated, with feedback being:

> ***Useful information provided from an agent (teacher, peer, book, parent, self or personal experience) which supports learning, relates to learning goals, regarding aspects of one's performance or understanding, and is utilised to improve one's learning of science.***

This conceptualisation of feedback will be used to examine the responses of students about what they perceived helped their learning. This analysis will highlight any oral interactions between themselves and the teacher, which students felt were beneficial in supporting their learning. The analysis will pay particular attention to any approaches cited relating to the conceptualised feedback definition that include useful information provided from an agent (teacher, peer, book, parent, self or personal experience), and information related to learning goals which students indicate supports their learning of science. Which, if any, of the oral interactions between the teacher and the students they perceive provide both useful information which helps learning *and* is related to goals, for this study encompass types of oral feedback that occur within secondary science classrooms.

The features that students indicated helped their learning are self-reported, which is a valid means of ascertaining results, as research relying on self-reported data has yielded important findings (De Groot, 2002). Every student interviewed claimed that they had learnt something in all of the lessons, and when questioned they were able to articulate what had helped their learning. Research has shown students are capable of conceptualising and articulating learning strategies and processes that are beneficial to their learning (Gipps et al., 2000; McCallum et al., 2000; Murtagh, 2014). In total, across the ten teachers, 84 students were interviewed. Interview recordings took place immediately after lessons with groups of students selected from the class that had been observed. All students were purposefully chosen as they had interacted orally with the teacher at some point during the lesson. Recordings were transcribed and a thematic analysis of the data was undertaken to identify and refine themes in order to saturate categories and links, and to identify relationships employing the processes proposed by Bryman (2012) and discussed in Chapter 3. Table 5.1 summarises the range of students interviewed across the study.

Subject / Year Group	Biology	Chemistry	Physics	Total
7	7	5		12
8		5	1	6
9		2	8	10
10	5	8	9	22
11	3			3
12	2	12		14
13	2	7	8	17
Total	19	39	26	84

Table 5.1 Range of students interviewed for study

It is the findings from these student interviews that form the analysis of this chapter. Findings are strengthened by drawing on data collected across multiple classrooms and large numbers of students. The subsequent data analysis of students' perceptions in science classrooms, identifies a number of factors that have been referenced in previous research studies, as well as highlighting categories of oral feedback types, which add to the knowledge in this field.

5.2 All Approaches Perceived By Students To Help Learning

Students' responses indicated a range of different approaches that they perceived helped their learning. Some of these linked to oral interactions between themselves and the teacher, whereas others were associated with different aspects of what occurred in the classroom. For the students interviewed, there were a number of approaches they perceived that supported their learning more than oral interactions with the teacher; these were visuals and peer collaboration. Oral interactions students perceived supported their learning, and also related to learning goals, are: *discrepancy* feedback, interactions regarding success criteria and open questions. As these oral types align to the conceptualisation of feedback derived from the literature, they are classed as oral feedback types evidenced in the science classrooms of this study. The other practice perceived by students to support learning, was linked to the self-directed learning behaviours that the teacher promoted them to undertake as a consequence of an oral interaction. What characterised these various oral interactions, and their connections to teachers' perceptions identified from the teacher interviews in Chapter 4, will be explored throughout this chapter.

All of the different approaches perceived to help learning that were cited by multiple students across all the interviews are shown in Figure 5.1. The total number of lessons in which student interviews referenced the approach (out of the 38 lessons) is shown along with the total number of students who referenced that approach. As students were interviewed in groups, this means that there were more often than not multiple references for a particular approach during a group interview. This therefore explains why the number of references for a particular category is higher than the number of lessons.

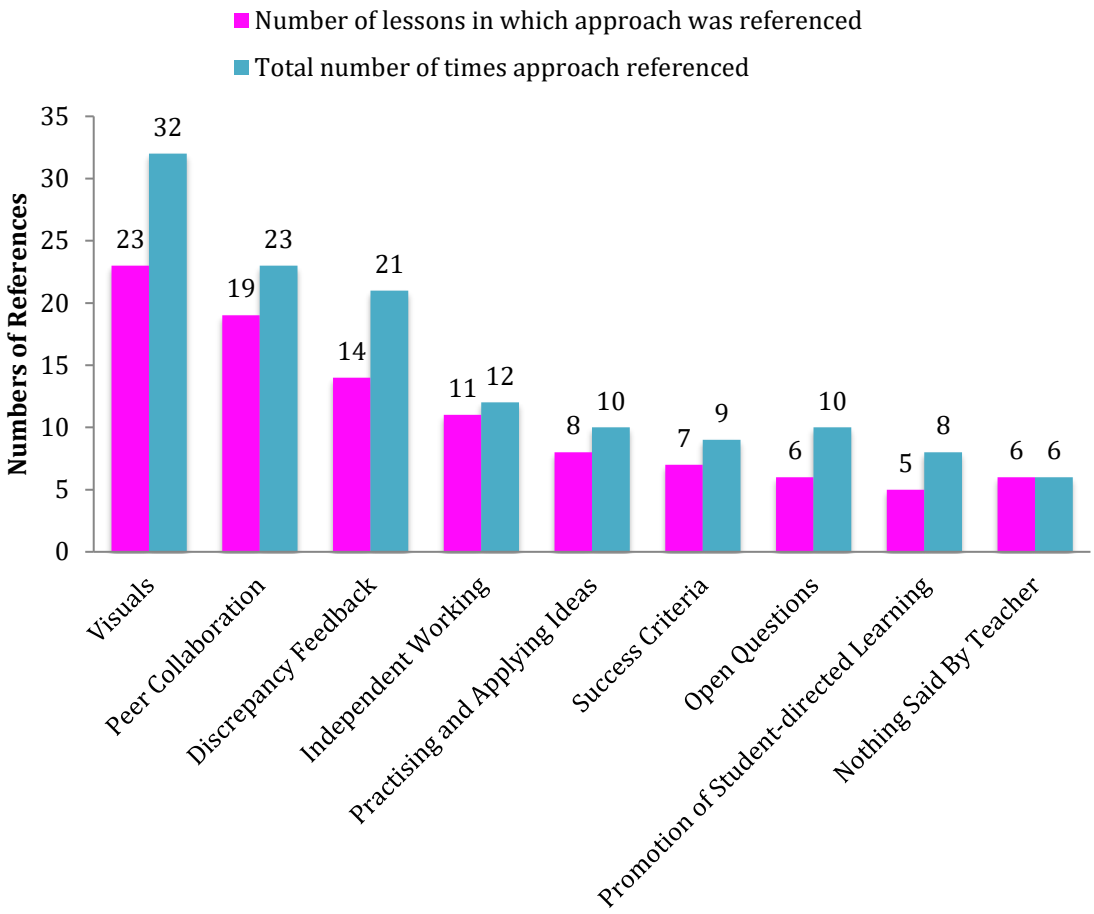


Figure 5.1 Distribution of all approaches cited by multiple students

From the student responses, oral interactions were perceived not to be as beneficial in helping their learning as other approaches. Indeed, one student explained that what the teacher had said had:

> *Not really helped me learn, it helped me do the task yeah, but I think things to help you learn you sort of find that on your own'. (Isobel, Lesson 2 Student Interview)*

The students' perception of tasks and learning being linked but different concurs with the idea of 'studenting' as opposed to 'learning' (Biesta, 2015). Identified approaches associated with oral interactions between the teacher and the students, they perceived supported their learning are: (1) *Discrepancy* feedback – ideas of how to improve, or identifying errors or misunderstandings. (2) Interactions about success criteria – e.g. ideas related to quality, such as using teacher

generated rubrics, exam question mark schemes. (3) Open questions – questions that were perceived to make the students think. (4) Promoting student-directed learning – Teacher practice in which students were provoked to work on their own or with peers as a consequence of interacting with the teacher.

Sources of useful information can be derived from multiple agents including: teacher; peer; book; parent; self or personal experience (Hattie & Timperley, 2007; Shute, 2007, 2008; Voerman et al., 2014). The approaches students perceived provided useful information to help learning, and not associated with oral interactions between them and the teacher are: (1) visuals – any source of useful information that supports the students' learning as a result of something that they can directly physically see and engage with. The word *visual* is used rather than *visualisation* as it was being able to see something tangible that students perceived helped their learning rather than a mental construct. Visuals students discussed included images, pre-prepared artefacts, practical work and in-lesson modelled visuals. The various sub-categories identified covered a variety of different representations that were either linguistic representations, i.e. they contained words, or non-linguistic representations, i.e. they contained no words. Therefore, an additional source of useful information that can be added to the list that has particular cogency for the teaching of science is practical work. Nonetheless, even though it is the visuals that the students cite helped learning, these were accompanied by oral interactions between them and the teachers whilst they were being undertaken, which may have helped the students' construct meaning; however, they did not refer to the oral interactions in these responses explicitly. (2) Peer collaboration – the opportunity to discuss with peers. This is categorised under non-oral even though it is associated with dialogue, as the direction of the interactions are not between the teacher and the student but rather between one student and another. Students being activated as learning resources for each other has been identified as a pedagogical approach which supports students' learning (Johnson, et al., 2000; Johnson et al., 1981; Kyndt et al., 2013; Nunnery et al., 2013; Nuthall, 2007; Puzio & Colby, 2013). Sociocultural constructivism was also highlighted as a key constituent of effective learning in science, in which the social dimension of learning with others plays a part in supporting students understanding, and appreciation of the nature of scientific activity (Agarkar & Brock, 2017; Harlen et al., 2015; Harrison, 2015; Kapon, 2017; Leach & Scott, 2003). (3) Independent working – conducting own research and engaging in work separate of the teacher. Students working independently to construct meaning align with cognitive

constructivist theories, and as such differs from those who cited working with peers as a mechanism to support their learning. Both of these constructivist theories are thought to underpin learning in science (Driver et al., 1994; Driver et al., 2000; Harrison, 2015; Harlen et al., 2015; James, 2006; Leach and Scott, 2003; Scott, 1998). (4) Practising and applying learning – practising by going over ideas again, applying ideas using multiple contexts. Being able to utilise ideas and models about phenomena in multiple contexts is a vital component of learning in science (Kapon, 2017; Leach & Scott, 2003). Alongside the benefits of peer collaboration and independent working, there is the added advantage reported from several research studies associated with students mastering concepts due to deliberate practice under supervision (Howard, 2014). Learning by making errors and correcting mistakes, alongside deliberate practice, not only benefits learning gains (Howard, 2014); it is fundamental to the nature of science and accounts for many major scientific discoveries, with Fleming and penicillin being a well known example.

With regards to the conceptualisation of feedback presented by this study, the sources of useful information listed above are not classed as feedback as they did not also include direct discussions with the teacher related to learning goals. All of these sources of information are consistent with a constructivist approach to learning, and their inclusion is of relevance especially when compared against the literature in section 2.3 and 2.4 related to learning theories and approaches utilised as part of effective teaching and learning in science (Harlen et al., 2015; Gatsby, 2017; Millar, 2004; Osborne et al., 2003). Student-to-student interactions fall outside the remit of this study and, as such in comparison to the conceptualisation of feedback presented, cannot be classed as feedback. All of the interactions that occurred between students could however, form part of future studies conducted in the field, looking at the feedback language that contributes to learning as part of peer collaborations. As Nuthall (2007) states, “peer interactions and social relationships are equally important and need to be carefully understood if student learning is to be explained and managed effectively” (p. 83).

However, there is one approach that the students identified when asked about what helped their learning that is more of an antithesis to oral interactions; namely, that of no oral communication at all. However, as it was cited by a number of students, its inclusion in the data analysis is of importance. When asked the question, *‘Was there anything the teacher said that helped you learn?’* a number of students paused and waited, sometimes a considerable amount of time, before responding:

Erm, personally, no not really. (Belle, Lesson 4, Student Interview)

The students were not saying that the teacher had said nothing in the lesson or that they had not learnt anything in the lesson; rather, that they thought that nothing the teacher had said had, as far as they could recall, been beneficial in helping them learn. All of the students who cited 'nothing the teacher said' as helping did cite other approaches utilised within the lesson as having helped them learn. This category, as it is not associated with any oral interaction or classroom approach, will not be explored further in this chapter.

From their responses, students indicated that they perceived a range of different sources of information supported their learning, including peers, the teacher and reference materials amongst others. Students' perceptions regarding useful information being derived from multiple agents (Hattie & Timperley, 2007; Shute, 2007, 2008; Voerman et al., 2014) aligns to the conceptualisation of feedback derived by this study, and to constructivist theories of learning argued to underpin effective learning in science (Agarkar & Brock, 2017; Harlen et al., 2015; Harrison, 2015; Kapon, 2017; Leach & Scott, 2003).

The following section explores the oral interactions referenced by students, that, when interrogated against the derived feedback definition from the literature, included both useful information that students perceived helped learning *and* are related to goals. It is these oral interactions that will subsequently be classed as oral feedback. These oral feedback types were subsequently added to the analytical framework and utilised when analysing teachers' classroom practice in order to answer research question 4.

5.3 Oral Feedback Types

This section explores the responses from students that have been synthesised against the conceptualisation of feedback derived from literature and classed as oral feedback. The categories were identified as a consequence of the constant comparative data analysis. The reason that these types of oral interactions are defined as oral feedback is because they align to the conceptualised feedback definition, incorporating both aspects identified previously. Namely, they provide: (1) useful information from an agent (teacher, peer, book, parent, self or personal

experience) that students indicate supports their learning, and (2) information related to learning goals that students indicate supports their learning. How the identified oral feedback types are affiliated to learning theories, especially those underpinning science learning will be discussed, alongside previous findings in the field and areas of interest related to the aim of this study.

5.3.1 *Discrepancy* Feedback

The most frequently cited oral feedback type that students perceived helped their learning, and was related to learning goals, and hence congruent with the derived conceptualisation of feedback, was *discrepancy* feedback. This model of feedback proposed in Chapter 2 has been shown in Chapter 4 to resonate with teachers' conceptualisation of feedback. During the analysis of the student interviews, *discrepancy* oral feedback interactions were categorised using the characteristics highlighted by the teachers and as such involved teachers:

1. Providing students with ideas of how to improve:

> *Sarah: Probably when Miss came round and then showed us how to work out the speed on the graph.*
> *Interviewer: Yes because she came round and had a chat with you didn't she about how to calculate the speed. What was it that she said that helped?*
> *Tanya: Erm that you like, draw the line and then you like draw it upwards and not on where we find one, where one point is and then we use a ruler to draw it up and then we take it down at both sides and we kind of divide it. (Isobel, Student Interview Lesson 4)*

2. Identifying students' errors or misunderstandings:

> *She picked up a few things, we did it in centimetres by accident when we wrote the results down, so that helped us to realise we had done it wrong so we could do it right again. (Charis, Student Interview Lesson 3)*

The high frequency of references to *discrepancy* feedback highlighting ideas for improvement and/or spotting of errors and/or misunderstandings, indicate that students perceive these oral interactions as valuable for their learning. Whilst a large corpus of research affirms the benefits of *discrepancy* feedback (Carnell,

2000; Hattie & Timperley, 2007; Kluger & DeNisi, 1996; Shute, 2007, 2008), others have claimed that *progress* feedback is more influential in improving students' learning strategies and motivation (Schunk & Swartz, 1993; Schunk & Ertmer, 1999; Williams, 2010). Nonetheless, the responses of students in this study indicate that, for them, discussions alluding to aspects of their work that have been done well in relation to learning goals are not as effectual as other types of oral interactions. As such, students' perceptions indicate the value to them of the feed forward model proposed by Hattie and Timperley (2007) of 'What should I do to improve?'

However, what is of interest, and notable due to its absence, is the importance afforded by the students of *progress* feedback as a mechanism for supporting their learning, as this was a form of oral interaction that was not cited as being helpful by students across the interviews. Such interactions relate to Hattie and Timperley's (2007) feed back model 'How am I doing so far related to the learning intentions?' The lack of reference is in contrast to those who contend that *progress* feedback is more influential in improving students' learning strategies and motivation (Schunk & Swartz, 1993; Schunk & Ertmer, 1999). Potential reasons for students' lack of citation of this form of oral interaction may be due to the historical, institutional, and cultural context, established over time between the teachers and students (Mercer, 2010; Scott, 2007) in these particular 'outstanding' schools. The students' perceptions in this study therefore, qualify ideas propositioned by many others in the field. Consequently, for this study even though *progress* information does relate to learning goals, as the students do not perceive them as useful discussions that support learning, then these interactions within this inquiry are not classed as oral feedback.

From the synthesis of teachers' and students' perceptions alongside the conceptualisation of feedback presented by this study, it is possible to provide insight into the characteristics of *discrepancy* feedback; specifically, that they provide students with ideas of how to improve or support them in identifying errors/misunderstandings. These are intrinsic aspects of oral feedback interactions occurring within science classrooms that have hitherto been scarcely reported and therefore provide understanding as to how educators can conduct oral feedback in science. The fact that both teachers and students identified this practice is to be expected, as "teachers are much more effective in identifying errors or misconceptions in students' work than peers or the students themselves*"* (Nicol & Macfarlane-Dick, 2006, p. 9).

Even though *discrepancy* feedback was the highest reported oral feedback type cited across the students interviewed in this study, they were not reported as frequently as visuals or peer collaboration. Nonetheless, their importance in terms of perceived benefits for learning is a key facet of answering the research question 3 pertaining to *'the characteristics of oral interactions students perceive improves their learning'*.

5.3.2 Success Criteria Interactions

Following *discrepancy* feedback, the next two categories of oral feedback, namely interactions about success criteria and the use of open questioning, were cited a similar number of times by students. As the number of lessons associated with interactions involving success criteria is greater than for open questioning, even though open questioning had more references, this is the next category to be examined.

Although aspects of some of the conversations regarding success criteria involved teachers using exemplars as a means of aiding students' in understanding the quality associated with the learning goal, the responses in this category are distinct from those categorised as useful sources of information. This is because the interactions identified here included the student and the teacher *conversing* about the visuals, whereas the examples identified in the section discussing useful sources of information, involved the students *working* independently of the teacher on their own or with peers whilst using the exemplars.

From the students' responses, a number of different teaching artefacts were identified as helping their learning whilst discussing success criteria during oral interactions between themselves and the teacher. These included:

Teacher generated rubrics such as those used for writing up science investigations:

What we needed to do to get the distinction, we were doing the pass stuff today but going to like, exactly what we needed to do. (Flora, Student Interview Lesson 1)

Exam questions mark schemes:

It was when he talked to the whole class and like pointed out in each answer where the marks have come from. So it was kind of helpful for him to say … 'Oh you've got full marks but it's when you know why you've got full marks or no marks'. (Eric, Student Interview Lesson 4)

In terms of the conceptualised definition of feedback in Chapter 2, interactions involving success criteria link to the learning goals and "may relate to specific attainments or understandings or to differing qualities of experience" (Hattie & Timperley, 2007, p. 88). Success criteria interactions align to the 'feed up' model, 'what am I going to learn, what are the learning intentions/goal?' Therefore, dialogue about success criteria does not constitute *discrepancy* information, 'where to next?' but rather an identification of what quality and the performance at the desired level would involve (Hattie and Timperley, 2007). Discussions regarding the quality of work are a key premise for effective feedback if students are to improve (Sadler, 1989; Hattie & Gan, 2017). Such discussions have the potential to involve the student in making evaluative judgements about their own work and that of others, as well as being able to regulate what they are doing (see section 2.9.1). Hence, developing the evaluative knowledge capacity of students to monitor the quality during actual production. All of these practices will support students in coming to share the teacher's vision of the subject matter, developing their own guild knowledge and becoming masters taking responsibility for their own learning (Sadler, 1989; Yang and Carless, 2013).

Nonetheless, students citing success criteria interactions as helpful to their learning was not unexpected. However, what was unforeseen was that not one of the teachers, when interviewed about their definition of feedback or how they perceived they practised it, made any reference at all to discussions relating to the learning goals or quality associated with them. As with *discrepancy* feedback, interactions regarding success criteria can be accomplished between teachers and students drawing on either convergent, behaviourist approaches or divergent, constructivist views of learning, aspects of the oral interactions that will be examined in the next chapter looking at teachers' classroom practices.

5.3.3 Open Questions

The final category presented by this study associated with oral feedback is the use of open questions. Not only were these questions professed as being helpful by the students, but also the perceived impacts the use of them had on the their learning behaviours. Students described how the open questions helped their learning as they made them responsible for their own thinking:

> *Yvette: He asks us questions and makes us think for ourselves, I think that's one of the things about Sir, he kind of like makes us, you know, and asks us and then points to people and says what's this?*
>
> *Zoë: Yeah, yeah instead of saying the answer and stuff yeah. (Dillon, Student Interview Lesson 3)*

In conjunction with being made to think, the other characteristics that students believed helped their learning as a consequence of being asked open questions, were linked to the behaviours that the teachers engendered in them; expressly that they needed to work out the answers for themselves. This was perceived as being a consequence of the teachers not providing the students with answers.

> *Charlotte: Well when he didn't give us the answer and we kind of had to work it out on our own.*
>
> *Daisy: And that's probably a good thing.*
>
> *Charlotte: Yeah.*
>
> *Daisy: That we actually did go about it ourselves.*
>
> *Charlotte: Yeah rather than just getting help.*
>
> *Daisy: We asked for help and he said no which probably turned out to be a good thing.*
>
> *Charlotte: As long as we made it in the end. (Garry, Student Interview Lesson 1)*

Questions perceived by students as helping their learning were very clearly associated with making them think, along with the teacher not giving them the answers, so that students had to work the answers out on their own or with their peers. This form of questioning links to divergent ideal typical practices and affords teachers the opportunity to establish what students know and therefore teach them in the *Zone of Proximal Development* (Torrance and Pryor, 2001; Vygotsky, 1986). Such divergent approaches to the use of questions link to a social constructivist view of education and have the potential to support teachers in science in identifying the "*horizon of possibilities"* (James, 2006, p. 57) related to students' differing levels of understanding and starting points. As such, open questions are an important aspect of teaching and learning in science as they enable students' ideas to be explored, challenged and reasoning opened up, in order to improve their understanding (Driver et al., 2000; Leach & Scott, 2003).

Open questions are also a mechanism to provoke students into self-directed learning by increasing their responsibility, which can potentially improve student autonomy, and learning (Blanchard, 2008, 2009; Dann, 2015a, 2018; Hargreaves, 2012, 2013, 2014; Hattie & Timperley, 2007; Nuthall, 2007; Sadler, 1989; Torrance, 2012; Watkins et al., 2002, 2007). Teachers who use open questions in order to build classroom discussions in science can also help students think more deeply, challenge them cognitively and learn more effectively (Alexander, 2014; Driver et al., 1994; Harrison, 2015).

There have been contradictory arguments from the literature with regards to questions and whether or not they are perceived as a form of feedback. Several studies have claimed the benefits of divergent and open questions in feedback (Brookhart, 2012; Dann, 2018; Elliott et al., 2016; Gipps et al., 2000; Hargreaves, 2013, 2014; Hargreaves et al., 2000; Torrance & Pryor, 2001), whilst others claim that there has been a lack of high quality evidence or consideration of their utilisation from the perspective of the student (Elliott et al., 2016; Voerman et al., 2012) to be able to justify an opinion on them. Therefore, in terms of the conceptualisation of feedback presented in this study, the beneficial aspects perceived by students of open questions, means they are classed as a form or oral feedback which provoke and support learning in science classrooms.

In section 2.7.3 only two responses by students as a consequence of feedback were identified as likely to improve learning/performance. These being

increasing the aspiration for the student or indicating they needed to *increase their effort* (Kluger & DeNisi, 1996; Wiliam, 2011). From the analysis of students' responses, the *increased aspirations and effort* that they have indicated they perceive have helped their learning, have been in the cognitive domain as opposed to the physical. In other words, it is more beneficial for them to persist and think more deeply about ideas and concepts to be able to construct their own meaning. Their perspective therefore indicates that they appreciate constructivist approaches to learning, rather than the behaviourist ones of accumulating knowledge provided by the teacher.

Whether or not the teachers in this study utilise oral feedback: *discrepancy* feedback; success criteria interactions; open questions, utilising convergent and behaviourist approaches, or divergent and constructivist approaches, along with any behaviours they engender in their students, will be examined when teachers' classroom practices are analysed in Chapter 6. The final type of oral interaction that occurred between the teacher and students and provoked students to work independently, were affiliated with teacher practices in which they promoted self-directed learning and will be considered in the next section.

5.4 Other Beneficial Oral Interaction - Promotion of Student-directed Learning

Being provoked by the teacher to work independently of them was perceived by a number of students to help their learning, and involved the teacher promoting student-directed learning, undertaken on their own or with peers:

> *Alison: Sir likes to go, 'Oh just have a little think about that on your own' you know what I mean … Aye, so making us think instead of spoon-feeding us.*
>
> *Barney: I'm not very keen on that. (Garry, Lesson 3 Student Interview)*

Even though these approaches resulted in the students working independently, these strategies were instigated as a consequence of oral interactions between the teacher and student, and as such any of these occurrences are therefore relevant to this study. However, it is not the oral interaction itself, i.e. provoking the student to persevere and engage in work independently of the teacher that is important in terms of supporting learning; on the

contrary, it is the fact that it is the student who is actually doing the work that is the more important consequence of this type of oral interaction.

Students acknowledging the benefit of such interactions, and the subsequent behaviours they are provoked to undertake, replicates points made previously and findings from other studies (Blanchard, 2008, 2009; Dann, 2015a; Hargreaves, 2012, 2013, 2014; Nuthall, 2007; Tunstall & Gipps, 1996; Vercauteren, 2009; Voerman, et al., 2014; Watkins et al., 2002, 2007), in which the shift in the locus of responsibility from the teacher to the student was seen as a powerful way to increase student autonomy and enhance learning (see section 2.9.1). Such approaches to teaching align with a constructivist view and the more progressive purposes of learning required by today's learners, and would involve students being responsible for utilising cognitive tactics and strategies to build meaning. The sources of useful information, again, are the student or their peers (Hattie & Timperley, 2007).

In summary, the distribution of all approaches in relation to students' perceptions and the derived conceptualisation of feedback can be seen in Figure 5.2. It is worth noting that sections of Figure 5.2, in which no types are indicated is because, either they included oral interactions from the teacher that students did not cite as helpful to their learning, or they include categories that would not be related to oral interactions. Such categories would include written feedback types and exploration of them lies outside the scope of this study.

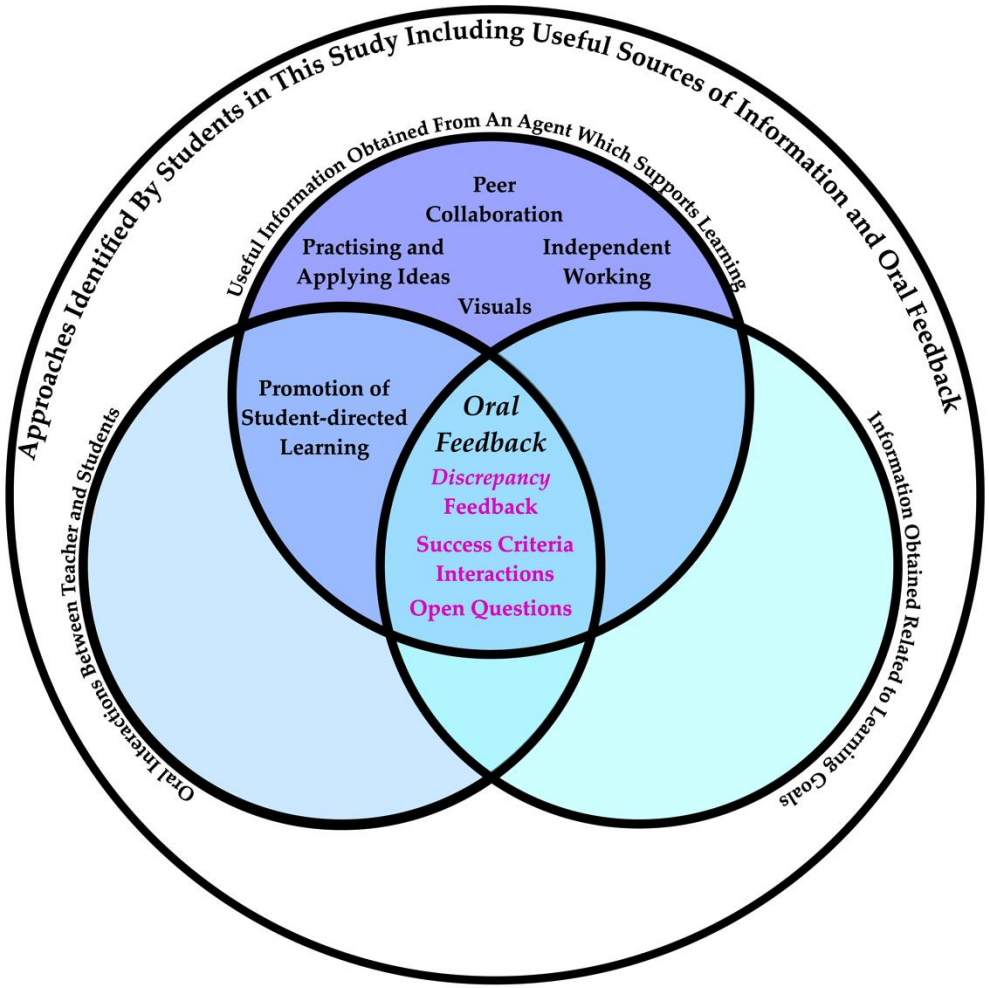


Figure 5.2 Comparison of students' perceptions and study's feedback definition

5.5 Comparison of Teacher and Student Perceptions

In Chapter 4 a variety of different aspects connected to how teachers conceptualised feedback was analysed, with their distribution across the teachers shown. Having now conducted the analysis of students' perceptions, it is possible to see how the categories of oral feedback practices believed to help learning are similar, or different, for both teachers and students.

5.5.1 Use of Oral Feedback Types

Table 5.2 indicates how students' perceived the oral interaction practices of each of the teachers that helped their learning.

Number of Lessons Referenced / Teacher	***Discrepancy* feedback**	**Success Criteria Interactions**	**Open Questioning**	**Promotion of Student Directed Learning**
Belle		**1**		
Charis	**3**	**1**		
Dillon	**3**		**2**	**2**
Eric	**2**	**1**		
Flora	**1**	**1**		
Garry	**1**		**3**	**2**
Henry		**1**	**1**	**1**
Isobel	**3**			
Jacob	**1**	**1**		
Kris		**1**		
Totals Across Teachers	**14**	**7**	**6**	**5**

Table 5.2 Student perceived distribution of oral interaction types

From the analysis of data from both teacher and student perceptions, both identified the following oral feedback types as beneficial to learning:

- *Discrepancy* feedback – cited by all ten teachers as part of their definition of feedback, largest cited oral feedback type by students.
- Open questioning - involves asking questions which make students think, along with the teacher not giving them the answers, so that they have to work the answers out on their own or with their peers. Nine out of teachers and many students identified all aspects relating to the implementation of open divergent questions as features that supported learning.

From the analysis of students' perceptions (see Table 5.2), and those reported by the teachers (see sections 4.2 and 4.3), similarities and differences with regards to teachers' oral feedback practices could be identified. These comparisons can be seen for all oral feedback types. Both *discrepancy* feedback and open questioning in Figures 5.3 and 5.4 show teachers' perceptions alongside students'. However, Figure 5.5 indicates how students perceived teachers practices related to interactions regarding success criteria without the comparative analysis of what teachers' thought. This is because interactions related to success criteria were not a type identified by teachers in this study, and only referenced by the students.

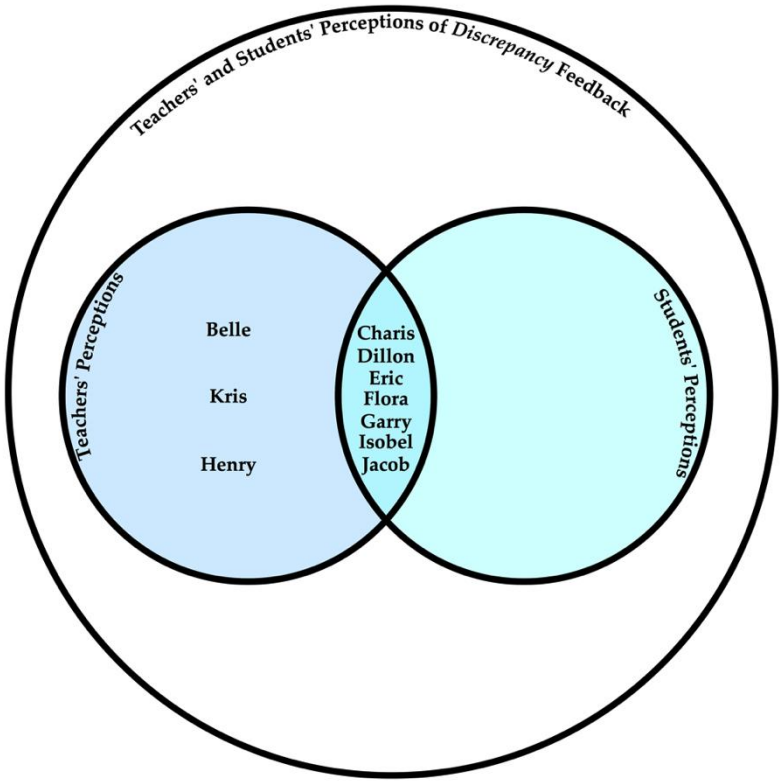


Figure 5.3 Teachers' and students' perceptions of *discrepancy* feedback

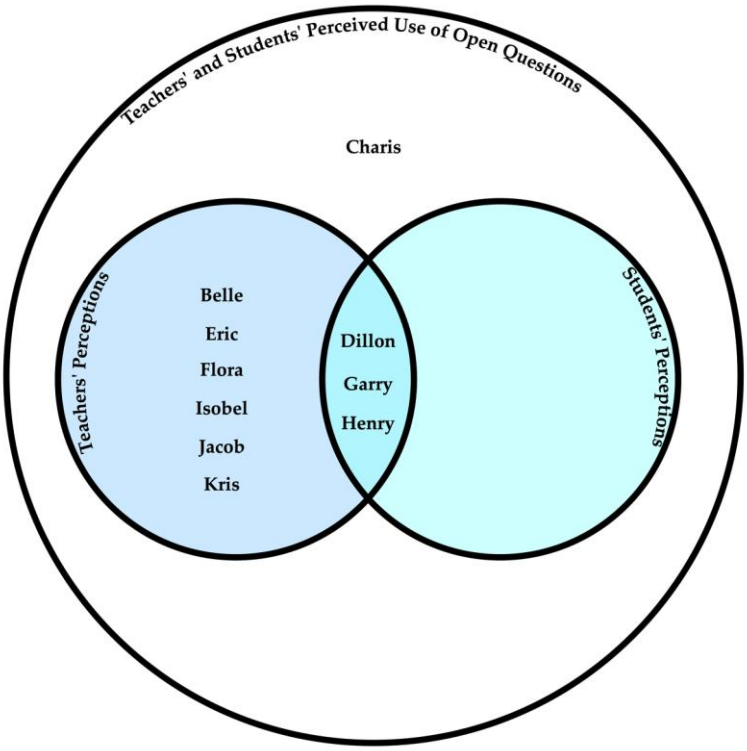


Figure 5.4 Teachers' and students' perceived use of open questions

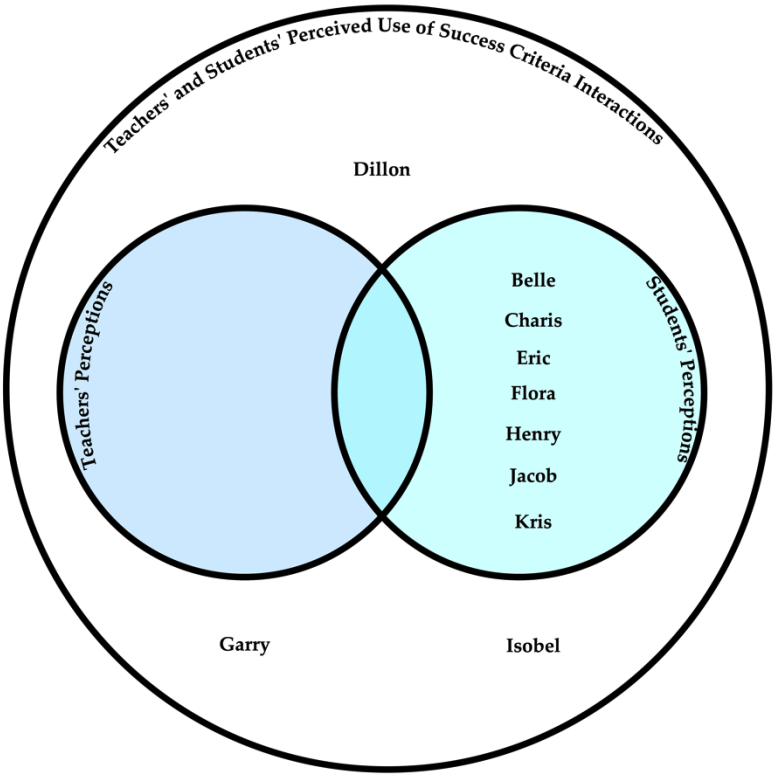


Figure 5.5 Teachers' and students' perceived use of success criteria

It was highlighted in Chapter 4 that there were a number of teachers (See Figure 4.2 - Belle, Dillon, Eric, Flora and Garry) whose perceptions of their feedback

practices included the idea of them promoting student-directed learning in the feedback process and supporting students in generating their own solutions. This is thought to provoke students to become sources of evaluative information by shifting the locus of control and is seen as powerful for the learner (Gipps et al., 2000; Hargreaves, 2011; Sadler 1989). From the group of teachers who proposed engendering these behaviours in students, only Dillon and Garry were perceived by students as using it to help their learning. However, Henry, who discussed this in terms of his conceptualisation of feedback, did not refer to it when discussing his utilisation of it, whereas the students perceived that he was one of the teachers who promoted these learning behaviours. From data synthesised across the teacher and student perceptions, some teachers' actions do not match with their feedback conceptualisation or practices. This incongruence may in part be due to teachers' underlying differing beliefs of learning (Agarkar & Brock, 2017; Black & Wiliam, 1998a, 1998b; Gipps et al., 2000; Hargreaves et al., 2000; Torrance & Pryor, 2001).

It should be noted that the data analysed so far is from interviews of both teachers and students, and that their perceptions have been synthesised against a conceptualisation of feedback derived from literature. As such, how this translates to teachers' actual feedback practices, and previous work in the field, will be of more significance when teachers' classroom practices are analysed. This comparison between the conceptualisation and implementation of feedback, along with further comparisons to students' perceptions, will be discussed in depth in Chapter 6. However, it is interesting to identify teachers whose perceptions match those of the students, and the overlap of the characteristics of feedback that concur with the definition conceptualised by this study, and how both groups of participants perceive them to be beneficial to learning.

5.5.2 Types of Oral Feedback Cited

From the analysis, there are two key differences between teachers ' and students' perceptions of oral feedback when compared to the study's conceptualisation. The first was an additional category cited by teachers that was not perceived as important by students; namely, *progress* information. However, in this study it appears that even though teachers identified both *discrepancy* and *progress* models in their definition of feedback (see section 4.2.1), the students only cited *discrepancy* feedback as useful in helping them learn; that is, they perceived ideas on how to improve, correct errors and/or misunderstandings more beneficial for their learning than an indication of what they had done well in relation to learning goals. The views of the students' therefore concur with proponents of the benefits of

discrepancy feedback (Carnell, 2000; Hattie & Timperley, 2007; Kluger & DeNisi, 1996; Shute, 2007, 2008).

The second difference between the teachers and students was an additional category that students cited as helping their learning, which was not suggested by teachers; namely, interactions regarding success criteria. This may have been something that teachers perceived was already a facet of the *discrepancy* feedback. In order to achieve a learning goal, it is possible that interactions about success criteria are implicit in the definition. However, none of the teachers referenced learning goals explicitly in their interviews, and as was observed (see section 4.2.1.1) there were differences between the teachers with regards to their perceptions of what feedback was being utilised to improve, be that task performance or learning. Again these differences in perceptions could be attributed to teachers' views of learning and their role in enabling it in the classroom (Niederhauser & Stoddart, 2001). What is therefore of importance is how oral feedback as conceptualised in this study can be attributed to the teachers' practices in the classroom and synthesised against students' perceptions. This will form the basis of the exploration of Chapter 6.

5.6 Chapter Summary

In Chapter 2 a theoretical conceptualisation was derived from literature where feedback is defined as:

> ***Useful information provided from an agent (teacher, peer, book, parent, self or personal experience) which supports learning, relates to learning goals, regarding aspects of one's performance or understanding, and is utilised to improve one's learning of science.***

5.6.1 Research Question 3

This chapter aimed to address research question 3 and identify '*What types of oral interactions do students perceive as helping learning?'* with findings related to the analysis of students' perceptions explored. From the perspective of the students in this study, three types of oral interaction have been identified as feedback when their perceptions were synthesised against the derived feedback conceptualisation. These three oral interaction types add credence to the definition

espoused by the study as they were the only oral interactions undertaken between the teacher and the students directly that were perceived as helping learning, and all of which align to learning goals. As such these three oral interaction types are defined as oral feedback, and are:

- *Discrepancy* feedback - highlighting ideas for improvement and/or spotting of errors and/or misunderstandings related to learning goals;
- Success criteria interactions - indicating quality/standards associated with goals;
- Open questions – Making students think, along with the teacher not giving them the answers so, students have to work the answers out on their own or with their peers.

Both *discrepancy* and success criteria interactions are feedback types that have been identified by students in other studies and reviews and cited as having the greatest benefit for learners (Black & Wiliam, 1998b; Carless, 2006; Dann, 2015a; Hattie & Timperley, 2007; Kluger & DeNisi, 1996; Peterson & Irving, 2008; Sadler, 1989; Shute, 2007, 2008; Voerman et al., 2012, 2014 Williams, 2010). However, for the students in this study, *progress* information providing ideas relating to the actual level of performance (i.e. 'how am I going?' Hattie and Timperley, 2007) was not cited as beneficial for learning. Therefore, the perceptions of the students in science lessons in this study qualifies the more pervasive model of feedback advocated in the literature, and challenges the notion presented by others of the greater benefits to learners of *progress* feedback (Schunk & Swartz, 1993; Schunk & Ertmer, 1999; Williams, 2010).

With regards to all of the oral feedback interactions cited by students as being beneficial for their learning, by far the largest of these was *discrepancy* feedback. Students' perceptions aligned with teachers'; namely, that providing them with ideas of how to improve and/or highlighting errors and/or misunderstandings, which they subsequently respond to in order to develop learning, was identified as important, concurring with previous findings (Dann, 2015a; Peterson & Irving, 2008; Weeden & Winter, 1999; Weeden, et al., 2002; Williams, 2010).

Open questions as a type of feedback has been debated in the literature with a lack of high quality evidence, and limited reviews of their effectiveness viewed from the perspective of the student rather than that of the teachers cited as

limiting factors in reaching conclusions (Elliot et al., 2016; Voerman et al., 2012). The findings of this study show that students in science perceive open questions as helpful for learning, concurring with others who have alluded to the beneficial use of them in feedback (Brookhart, 2012; Dann, 2018; Elliott et al., 2016; Gipps et al., 2000; Hargreaves, 2013, 2014; Hargreaves et al., 2000; Torrance & Pryor, 2001).

Moreover, it is not only the idea of oral feedback that students have perceived as beneficial, but in addition the way in which the teacher provokes them to become a *dynamic* and active co-agent within this process by promoting student-directed learning and supporting them to think and make quality judgements about their work to resolve the problems they are facing. Furthermore, there was not a single student who said that they liked to be told the answers; in fact, conversely many cited that they valued the student-directed learning aspect of feedback interactions as they saw the long-term benefits for themselves as learners.

> *Euan: It's the instead of, here's the answer, think about it and get it done yourself because in an exam we haven't got Sir just stood there.*
>
> *Fred: Although I wish he was. (Garry, Student Interview Lesson 3)*

The idea that students find visuals helpful, along with working with others or on their own, affiliates to previous discussions regarding learning, especially learning in science, in which cognitive engagement was seen as being beneficial to students' burgeoning understanding in the subject (Agarkar & Brock, 2017; Harlen et al., 2015; Harrison, 2015; Leach & Scott, 2003; Millar, 2004). Alongside this, the notion that useful information can be derived from multiple agents is not new (Hattie & Timperley, 2007; Shute, 2007, 2008; Voerman et al., 2014), and the findings from this study add further credence to the idea of peers acting as sources of effective information (Gamlem & Smith, 2013; Williams, 2010). However, in addition, having conducted this study in science classrooms, the importance of students engaging in practical work as a source of useful information has been highlighted.

All of the oral feedback types, the useful sources of information and the students valuing being provoked to operate *dynamically* are associated with constructivist theories; be that cognitive or sociocultural, and all can be utilised with either convergent or divergent approaches. For the students in this study, it was

divergent; constructivist feedback practices that they perceived were more beneficial for their learning. The students' perceptions therefore correspond to previous findings in different contexts and settings (Dann, 2015a; Hargreaves, 2012, 2013, 2014; Murtagh, 2014; Plank et al., 2014; Sadler, 1989), and to constructivist views of learning, and especially learning in science discussed in Chapter 2 (Agarkar & Brock, 2017; Driver et al., 1994, 2000; Harrison, 2015; James, 2006; Leach & Scott, 2003). This is the first time that these oral feedback types have been identified as important in a secondary science specific context.

Finally students' and teachers' perceptions synthesised against this study's conceptualisation were compared and it was noted that:

- Both identified *discrepancy feedback* and open questions as oral feedback;
- Not all teachers' conceptions regarding their feedback practices matched those perceived by the students;
- Students did not rate *progress* information in the same way as teachers, and such interactions are therefore not classed as feedback by this study;
- Students did value interactions regarding success criteria, whereas teachers did not mention this aspect of communication related to learning goals.

The synthesis of students' and teachers' perceptions examined in this chapter and Chapter 4 has provided a lens through which teachers' classroom oral interactions can be examined. The theoretically derived definition of feedback has been supported by students' perceptions and the types of oral feedback identified. Behaviours have been highlighted that concur with previous research and provide insights as to perceived aspects of oral interactions that can benefit students' learning in science. These insights provide useful information as to how teachers can maximise oral feedback interactions between themselves and their students in science lessons in order to improve learning. It will therefore be of interest when analysing the teachers' classroom oral practices to see how many of the interactions that they undertake consist of the oral feedback types. In Chapter 6 the analysis of how teachers' classroom oral practices compared to the students' and teachers' perceptions and conceptualisation of feedback will be scrutinised in more

detail. Analysis of the students' responses identified a further type of oral interaction generated from the data; namely, interactions regarding success criteria, and this additional category was added to the data analysis framework to ground the examination of teachers' classroom practice in the data.

In summary, the analysis of students' perceptions of oral interactions that improve their learning in science has contributed to understanding in the field by qualifying previous findings related to: (1) oral feedback interactions that support learning (*discrepancy* feedback, success criteria interactions, open questions). (2) Student-directed learning behaviours that teachers promote in students by provoking them to operate as *dynamic* co-agents in the feedback process. (3) Sources of useful information that support students' learning in science, especially practical work. (4) Incongruence was also highlighted between teachers' and students' perceptions of oral feedback types, especially regarding *progress* information and interactions regarding success criteria.

The next chapter addresses research question 4 and examines science teachers' classroom practices against the conceptualisation of feedback derived from literature and the oral feedback types identified from the synthesis of it against students' perceptions. The analysis will highlight a variety of different aspects of science teachers' use of oral feedback within science classrooms as well as aspects related to their convergent and divergent oral interaction practices. Finally, a comparison between teachers' conceptualisations against their observed feedback practices will be presented.

Chapter 6 Teachers' Classroom Practice

6.1 Introduction

> *I came to a place where I realised that assessment wasn't just about telling the children where they're at but telling the children how to improve and engaging them in that process (Eric, Final Interview).*

This chapter investigates the results from 38 hours of lesson recordings and field notes obtained from all ten case study science teachers (a minimum of three full lessons per teacher). Lesson recordings were only coded after all interviews had been conducted and analysed, and all lessons observed. Lesson recordings were interrogated using the analytical framework generated from the synthesis of both teachers' and students' perceptions and observation field notes of oral interactions that occurred within science classrooms. The results were reviewed against the conceptualisation derived from literature of feedback presented in this study and students' perceptions of what helped them learn, to report findings in response to research question 4:

> *To what extent and in what ways do science teachers' oral interactions compare to their conceptualisation of oral feedback and students' perceptions of what helps learning?*

The chapter identifies science teachers' dominant oral interaction types and their use of oral feedback within lessons, and then analyses teachers' use of oral interaction types against their perceived oral feedback practice. The chapter concludes by presenting an argument that there exists a difference associated with feedback linked to teachers' practices and resultant student behaviours. As well as indicating insights in the field, this study contributes new knowledge, by generating from the data analysed a theoretical feedback framework developed from the ideal typical approaches proposed by Torrance and Pryor (2001). The resultant theoretical feedback framework highlights practical implications, allied to teachers' differing convergent and divergent practices.

In the previous chapters, teachers' conceptualisation of feedback and perceived classroom practices, along with types of oral interactions and useful sources of information that students perceived improved their learning, were examined alongside the theoretical conceptualisation of feedback derived from literature. The oral feedback types defined and views identified are only indicators of teachers' and students' acuities, and as such give an idea of the variety of different practices to examine when looking at teachers' use of oral feedback in the classroom. The other important factors indicated from the analysis of the teacher and student interviews link to teacher practices and how they empower and engage students as sources of evaluative information during oral feedback interactions. All of these different aspects will be explored throughout this chapter.

6.2 Distribution of All Types of Oral Interactions Across All Teachers

As discussed in Chapter 3, it was decided not to conduct the analysis of oral interactions at the time of the lessons, as opportunities to observe other aspects, such as those students with whom the teacher was interacting could have been missed. It was therefore decided to employ a post-observation analytical framework (Appendix 9). This framework was produced from the conflated sub-types of oral interactions evidenced from both teacher and student interviews, alongside additional types noted during lesson observations. A summary of where each different oral interaction type within the framework originated can be seen in Appendix 8. Moreover, the final analytical framework was employed to ascertain the number of oral interactions, which were undertaken in either whole class or small group/individual situation.

In order to provide clarity throughout the ensuing discussions regarding the different oral interaction types that were coded, exemplification for each code is provided in Table 6.1, drawing on examples from classroom oral interactions.

Name of Oral Interaction Type Code	Definition of Code	Example of Code
1. *Discrepancy* feedback	Teacher points out error/s with answer and/or teacher provides ideas of how to improve and/or teacher points out common misunderstandings.	Teacher read out a students paragraph about how the Earth's early atmosphere evolved; when they had finished reading it they went on to say *'the only mark that is missing there is saying why it remained constant for quite a long period of time* *… Jemma I am going to ask you separate that into two paragraphs please. The reason why I want you to separate it into two paragraphs people [addressing whole class] is that in science in exam questions very often it will say describe this graph and people write an explanation instead of a description and get no marks' (Eric, Lesson 3).*
2. *Progress* Information	Teacher provides progress information; i.e. information about what has been done well in relation to goal.	Teacher: *'I am really impressed with this by the way, you and Alison are the best reports in the class so far. Your writing was brilliant. The style of writing was very mature from both of you and I could tell it was your own writing and not copied and that you had really thought it through, I was very impressed with that'* (Flora, Lesson 3).
3. Promotion of Student-directed Learning	Teacher provokes students to work on own or with peers.	To work independently of the teacher on their own or with peers to generate own solutions. Teacher: *'there's no right or wrong answer it is just an idea, so I will leave you to it for now, whilst I go and talk to Kevin' (Garry, Lesson 2).*
4. Open Questions	Teacher asks open questions.	Teacher: *'Can we explain how an acidic buffer works using equations?' (Eric, Lesson 1)*
5. Closed Questions	Teacher asks closed questions.	Teacher: *'Eliza give me an example of a cell?' (Henry, Lesson 2)*

6. Interactions Regarding Success Criteria	Teacher provides information about the goal (learning or task performance), explaining what the students will be learning. Teacher provides information about the success criteria and/or what the quality/standards of work will look like at each different level.	Information regarding goal: Teacher*: 'This controlled assessment is about modelling the slip and forces between the rock layers. This will be modelled by simple laboratory equipment; you are going to test the hypothesis that as the force between the rock layers increases the amount of slip between the layers changes. So we need to plan an investigation to test that hypothesis' (Charis, Lesson 2).* Success Criteria: Teacher*: 'Have a look at the front (of the student workbook) at the criteria. We have got a P1, pass criteria, we've got an M1, merit criteria and we've got a distinction criteria.* *Let's just glance at those, the pass criteria is about carrying out quantitative and qualitative analytical techniques' (Flora, Lesson 1).*
7. Directive Teaching – Answers/ Science Explanation	Teacher provides answer/ direct teaching of the science.	Teacher is discussing with students how nitrogen gets into plants. Teacher: *'No, think about it you have Nitrogen in the air, N_2, how does that get into the soil?'* Students do not respond so teacher continues Teacher: *'Mmmmm ok a Nitrogen ion called nitrates'* Student: *'Ok shall I write down nitrates?'* Teacher: *'Yes write down nitrates' (Isobel, Lesson 1).*

8. Directive Teaching – Task Instructions	Teacher provides information/ instructions about task.	Teacher: *'Ok can you finish the one that you are on and then what you are going to do is you are going to put beakers without dye in the water back and then you are just going to, really carefully, maybe holding the test tube as well as the test tube rack put it back in the trays where you found it. Goggles back then sitting down. Finish the last one that you are on and I expect everyone to be packed away in three minutes off you go' (Belle, Lesson 3).*
9. Praise/ Punishment	Teacher provides generic praise/ punishment.	Teacher: *'Arthur, brilliant, ok' (Belle, Lesson 3)*
10. Summarising	Teacher summarises points made or earlier learning.	Teacher: *'Ok so last lesson we looked at immunity and vaccines do you remember. We looked at different types of vaccines and then we had a look at side effects and I said would you have that vaccine and some of you said yes and some of you said no and then I said it's hard luck because you've already had it when you were a few months old' (Kris, Lesson 4).*
11. Encourages Student	Teacher encourages student to participate in lesson.	Teacher: *'Go on you've used the magic word refraction, go on, yes, yes' (Dillon, Lesson 3).*

Table 6.1 Codes for all oral interactions coded in study

When analysing the lessons, oral interactions were recorded each time they changed. An example of a coded lesson extract can be seen in Appendix 16, and indicates how a number of different oral interactions are used throughout the duration of the whole class discussion including both feedback and non-feedback types.

The final analytical framework was then used to code all 38 lessons by recording every oral utterance undertaken by the teacher in order to identify the number of different events pertaining to each of the different oral types. All oral interaction types noted were then tallied and summed for all lessons. Information regarding the lengths of these interactions is not provided; e.g. a teacher could be

giving task instructions for a considerable time before a different oral type was uttered and subsequently noted. Therefore, even though someone only displayed low percentages of a particular oral feedback type, the instance of the dialogue could have lasted some time. From the coded lesson recordings, it was possible to identify the percentages of all of the different types of oral interactions that each teacher employed across all of their lessons. Table 6.2 indicates the frequency of each of the different oral interaction types noted across all of the teachers' lessons. The oral types have been grouped and ranked into those associated with non-feedback interactions and those with feedback interactions.

Type of Oral Interaction	**Frequency of Occurrence Across All Teachers**
Non-feedback	5,466 (79%)
• Task instructions	• 1,535 (22.2%)
• Answers or direct teaching of science	• 1,072 (15.5%)
• Closed questions	• 1,218 (17.6%)
• Praise/punishment	• 695 (10.0%)
• Encourages students	• 517 (7.5%)
• Summarising	• 231 (3.3%)
• Promotion of student-directed learning	• 140 (2.0%)
• *Progress* information	• 58 (0.8%)
Feedback	1,464 (21%)
• Open questions	• 832 (12.0%)
• Interactions regarding success criteria	• 401 (5.8%)
• *Discrepancy* feedback	• 231 (3.3%)
Total	6,930

Table 6.2 Frequency breakdown of all oral interactions

The data shows that for the case study teachers over a fifth of oral interactions were feedback. Table 6.3 shows a breakdown of the percentages of the different oral types for each of the individual teachers; again these are across all of their observed lessons. Percentages were used to conduct the comparative analysis across teachers, as not all teachers were observed for four lessons. Separate individual breakdowns of percentage distributions of each of the different oral interaction types for each individual teacher are attached in Appendix 17, in which they are shown in order of oral types associated with feedback and oral types not associated with feedback.

Oral Type	*Discrepancy*	*Progress*	Promotion of Student-directed Learning	Open Question	Closed Question	Success Criteria	Answer or Direct Teaching of Science	Task Instruction	Praise/ Punish	Summarising	Encouraging Students
Belle	10 (1%)	10 (1%)	8 (1%)	57 (5%)	234 (21%)*	52 (5%)	93 (8%)	292 (26%)*	305 (27%)*	23 (2%)	26 (2%)
Charis	45 (7%)	7 (1%)	5 (1%)	78 (11%)*	60 (9%)	36 (5%)	151 (22%)*	191 (28%)*	64 (9%)	19 (3%)	30 (4%)
Dillon	28 (3%)	4 (0%)	7 (1%)	186 (21%)*	180 (21%)*	17 (2%)	103 (12%)	171 (20%)*	53 (6%)	55 (6%)	66 (8%)
Eric	36 (6%)	8 (1%)	11 (2%)	159 (25%)*	82 (13%)	65 (10%)	55 (9%)	90 (14%)*	24 (4%)	27 (4%)	88 (14%)*
Flora	28 (4%)	4 (1%)	8 (1%)	68 (10%)	75 (12%)*	46 (7%)	101 (15%)*	186 (29%)*	62 (10%)	27 (4%)	47 (7%)
Garry	32 (5%)	12 (2%)	47 (8%)	128 (22%)*	60 (10%)	53 (9%)	62 (11%)*	125 (21%)*	23 (4%)	13 (2%)	32 (5%)
Henry	12 (2%)	5 (1%)	25 (5%)	59 (12%)	141 (28%)*	23 (5%)	69 (14%)*	85 (17%)*	19 (4%)	17 (3%)	50 (10%)
Isobel	19 (2%)	1 (0%)	15 (2%)	24 (3%)	234 (29%)*	33 (4%)	163 (20%)*	156 (20%)*	84 (11%)	26 (3%)	44 (6%)
Jacob	7 (1%)	0 (0%)	1 (0%)	33 (7%)	73 (15%)*	37 (8%)	163 (34%)*	88 (19%)*	20 (4%)	12 (3%)	40 (8%)
Kris	14 (2%)	7 (1%)	13 (2%)	40 (7%)	79 (13%)	39 (6%)	112 (19%)*	151 (25%)*	41 (7%)	12 (2%)	94 (16%)*
Totals	231 (3.3%)	58 (0.8%)	140 (2.0%)	832 (12.0%)	1218 (17.6%)	401 (5.8%)	1072 (15.5%)	1535 (22.2%)	695 (10.0%)	231 (3.3%)	517 (7.5%)

Table 6.3 Distribution of all oral types across all teachers

Values with an asterisk (*) indicate the most frequent teacher to student oral interaction types for each individual teacher

The data in Tables 6.2 and 6.3 show that teachers were more likely to engage in oral interactions that were not associated with feedback, with the largest oral interaction within the classrooms associated with giving task instructions. As the teachers in this case study all teach science and practical work, including health and safety implications, was prevalent throughout the lessons observed, it is therefore not surprising that for every teacher this was the largest oral interaction type in which they engaged. Table 6.3 shows the most frequent teacher to student oral interaction types across all the teachers were:

- Giving task instructions – noted for all 10 teachers.
- Providing answers and/or science explanations – noted for 7 of the teachers.
- Closed questions – noted for 6 of the teachers.
- Open questions – noted for 4 of the teachers.
- Encouraging students – noted for 2 of the teachers.
- Praise/punishment – noted for 1 of the teachers.

As well as differences in the most frequent oral types across the teachers, there are variations in the distribution of the different interactions. All of the different oral interaction types were coded for each of the teachers, irrespective of those they had discussed when asked about their perceptions of their own practice. It is the detailed examination of this data alongside the teachers' and students' perceptions and the conceptualisation of feedback derived from literature that is deliberated in this chapter.

This next section looks to address the research question 4 *'To what extent and in what ways do science teachers' oral interactions compare to their conceptualisation of oral feedback?'* The analysis indicated similarities and differences across the teachers that are considered in the subsequent sections of the chapter. Initially the use of oral feedback types will be examined with key findings relating to the analysis considered.

6.3 Teachers' Use of Oral Feedback Types

In the preceding chapters, a definition from the teachers' conceptualisation of feedback was presented; namely that feedback is: a process to support improvement of either task performance or learning - this can include *discrepancy* and/or *progress* information, which involves providing students ideas of what needs to be done and/or emphasising errors or misunderstandings; a two-way relationship between the teacher and the student in which both are active agents; students acting on the information to improve; encouraging *dynamic* student behaviours –

this entails teachers promoting student-directed learning by provoking students to generate solutions on their own or with peers. The teachers' definition closely aligned to the feedback conceptualisation theorised from the literature:

> ***Useful information provided from an agent (teacher, peer, book, parent, self or personal experience) which supports learning, relates to learning goals, regarding aspects of one's performance or understanding, and is utilised to improve one's learning of science.***

The main exception was the lack of reference by the teachers to learning goals. For this study, learning goals are considered an integral aspect of feedback, along with clarity for learners of what the learning goals constitute, especially in terms of clarity of quality i.e. success criteria, if feedback is to benefit learning (Brookhart, 2012; Chappuis, 2012; Hattie & Timperley, 2007; Hattie, 2012b; Hattie & Gan, 2017; Wiggins, 1997, 2012, 2016).

From the analysis of students' perceptions in comparison to the conceptualisation of feedback presented in this study, the oral feedback types that they believed were beneficial for their learning included: (1) *discrepancy* feedback (highlighting ideas for next steps, errors and/or misconceptions related to learning goals). (2) Interactions regarding success criteria (quality/standards) related to goals. (3) Open questions (involves asking questions in order to make students think, including not giving answers). However, students also perceived that there were other (non-oral) approaches that were beneficial to their learning, in particular the use of visuals and peer collaboration.

Students' perceptions indicated that *discrepancy* feedback was believed to be the most beneficial for their learning. The next most frequently reported types were open questions and success criteria interactions associated with the quality/standard of work and related to goals. All of these interactions have been classified as feedback in comparison to the conceptualisation derived from literature.

The first key point to note from the lesson analysis is that none of the teachers in the study had either *discrepancy* or success criteria interactions recorded within the top three types of oral interactions they undertook. That is not to say that the teachers did not engage in these types of interaction; on the contrary, they all did so to varying degrees. Rather, what can be stated is that these types of

interactions were not as common as some of the other types of oral interactions. This finding concurs with other research studies in which convergent evaluative interactions were most prevalently given to students (Chin, 2006; Gamlem & Munthe, 2014; Knight, 2003; Murtagh, 2014; Ruiz-Primo & Li, 2013; Vercauteren, 2009). Table 6.4 shows the number of different oral interactions that were undertaken between each of the teachers and the students in their classrooms. The interactions have been broken down into the number of oral feedback (*discrepancy* feedback, success criteria interactions, open questions) and non-oral feedback interactions they undertook.

Teacher	Individual Teachers Total Number of Oral Feedback Interactions	Individual Teachers Total Number of Non-oral Feedback Interactions	Total Number of Oral Interactions
Belle	119 (11%)	991 (89%)	1,110 (100%)
Charis	159 (23%)	527 (77%)	686 (100%)
Dillon	231 (27%)	639 (73%)	870 (100%)
Eric	260 (40%)	385 (60%)	645 (100%)
Flora	142 (22%)	510 (78%)	652 (100%)
Garry	213 (36%)	374 (64%)	587 (100%)
Henry*	94 (19%)*	411 (81%)*	505 (100%)*
Isobel	76 (10%)	723 (90%)	799 (100%)
Jacob*	77 (16%)*	397 (84%)*	474 (100%)*
Kris	93 (15%)	509 (85%)	602 (100%)
Totals	1,464 (21%)	5,466 (79%)	6,930 (100%)

Table 6.4 Oral and non-oral feedback interactions for all teachers

* Only observed for three lessons.

Table 6.4 shows that every teacher utilised all three oral feedback types within their teaching, but they did not do so equally. Figure 6.1 breaks down the oral feedback interactions into the three different types and shows the percentage distribution across all lessons for all the individual teachers. The purple bar indicates the aggregate value of all oral feedback interactions for each teacher. The teachers are then ranked in order from the most to the least in terms of their utilisation of oral feedback.

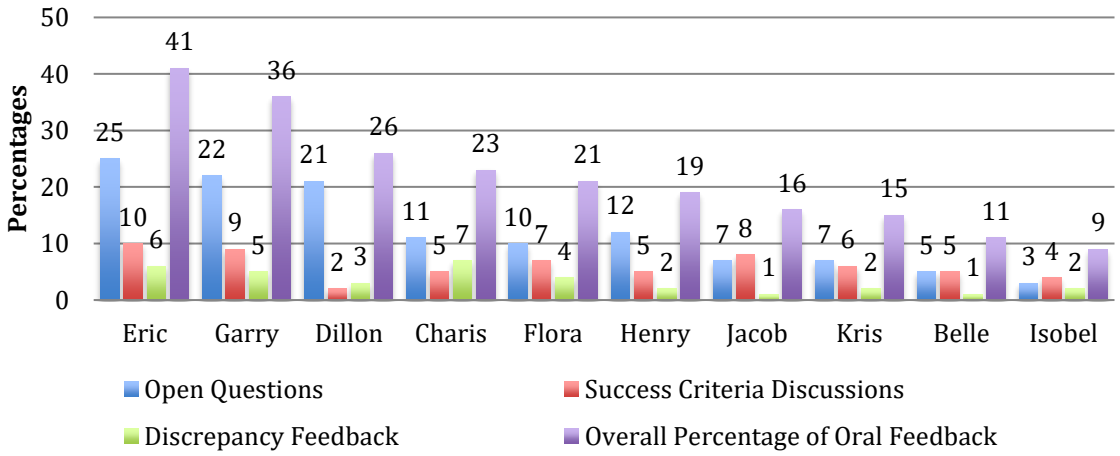


Figure 6.1 Distribution across teachers of oral feedback types

For eight of the ten teachers their main oral feedback type was open questions. However, the remaining two teachers – Jacob and Isobel –employed fewer open questions, and for them their dominant oral feedback type was interactions regarding success criteria. Table 6.5 shows the ranked comparative percentages of teachers' uses of open questions.

Teacher	Number of Open Questions Asked As A Percentage of All Oral Interactions for Each Individual Teacher
Eric	159 (25%)
Garry	128 (22%)
Dillon	186 (21%)
Henry*	59 (12%)
Charis	78 (11%)
Flora	68 (10%)
Kris	40 (7%)
Jacob*	33 (7%)
Belle	57 (5%)
Isobel	24 (3%)
Total Number of Open Questions Across All Lessons and Percentage of All Oral Interactions	832 (12%)

Table 6.5 Teachers' use of open questions

* Only observed and recorded for three lessons.

Questioning in all of its forms constitutes a major part of the oral interactions that occurred within the teachers' lessons. The fact that the use of questions featured so prominently in the practice of the teachers is unsurprising. They are science teachers, science is a subject that utilises questions as part of the scientific enquiry process in which evidence is considered and tested, and as such is an oft used pedagogical approach in science classrooms (Harrison, 2015; Harlen et al., 2015; Kapon, 2017; Leach & Scott, 2003, see section 2.3).

Only Eric and Garry employed more open than closed questions during their lessons. Charis, Flora and Dillon used similar frequencies of both types of questions, with all other teachers utilising closed questions as their dominant approach (Belle, Henry, Isobel, Jacob, Kris). The fact that more closed questions were prevalent across the teachers aligns with previous findings, in which it was claimed that the use of cognitively-demanding questions that really challenge students to think for themselves is a scarcely used practice, and one that is particularly resistant to change (Alexander, 2014; Gall, 1970). Even though the percentages and relative proportions of questioning are not necessarily the same as the figures quoted by Gall (1970), the comparative dominance of task instructions, followed by closed, and finally open, use of questions noted in this study concurs with Gall's (1970) work analysing questioning practices over a fifty year period (see section 2.4.3).

Teachers utilised questions to different degrees and in different ways, and this may signify teacher's underlying beliefs (Black & Wiliam, 1998b). The teachers in the study varied in their use of questions; there were those who aligned to the more behaviourist view of learning in science, in which science educators approach the teaching of the subject from the perspective of one who 'knows the right answer' i.e. a transmission approach to learning with students as *passive* recipients in a unidirectional action (Askew & Lodge, 2000; Bates, 2016; Bruner, 2001; Buhagiar, 2005). This was evidenced in this study through the dominant use of closed questions, an approach aligned to convergent practices, with the teacher providing the direct teaching of the science or answers, and as such doing the thinking for the student, exemplifying behaviourist assumptions.

Conversely, a minority of the teachers engaged with learners in joint activities (Bruner, 2001; Tunstall & Gipps, 1996) and employed open questions associated with divergent practices, as a mechanism to challenge students and make them think (Alexander, 2014; Torrance & Pryor, 2001). Open questions are a

tool to identify where students are in their learning in science, and as a means to engage them in a process in which they construct and reconstruct a series of self-explanations that evolve, change and replace one another or merge into a new self-explanation in order to develop scientific understanding (Agarkar & Brock, 2017, Kapon, 2017; Leach and Scott, 2003). Questioning employed in this way aligns to more constructivist views of learning, and the research evidence suggests that these approaches are more beneficial to learners in science (Bruner, 2001; Driver et al, 1994; Harrison, 2015). This corresponds to students' views in this study, which cited the use of open questions, as an approach that they believed was beneficial for their learning.

Teachers who utilised more open questions were more likely to engage in other forms of oral feedback perceived to help learning (i.e. *discrepancy* feedback and success criteria interactions). It is to be expected that teachers who used divergent questioning practices utilising open questions to ascertain evidence of students' thinking were more likely to employ oral feedback types. This is because the use of questions in this way is an inherent part of identifying where students are in their understanding, and is one way to enable the teacher to ascertain what next step ideas should be discussed, or what errors or misconceptions students harbour, all of which are aspects that were cited as constituent aspects of *discrepancy* interactions.

It is worth noting that for the eight of the ten teachers their least used oral feedback interaction was *discrepancy* feedback. This is of interest as *discrepancy* feedback was the oral interaction type that was cited by the students as being most helpful for their learning. This observation offers an insight into an area of teachers' classroom practice that, if changed, has the potential of benefitting learners. If teachers could find a way of using the time that they have with learners to increase the number of interactions focusing on *discrepancy* feedback, rather than some of the other forms of oral interactions they undertake perceived as being less beneficial to learners, then there is the possibility of making classroom talk more effectual for both teachers and students.

6.3.1 Whole-class vs Small Group Teaching

The teachers, in their initial interviews, raised another aspect of how they operationalised their use of oral feedback. This relates to teachers' perceptions regarding whether they engaged their students in oral feedback more frequently in whole-class or in small group/individual settings. The following data consist of all

the oral interactions that relate to the three oral feedback types presented by this study. As every oral interaction was coded when it occurred between both the teacher and the students, useful insights can be garnered as to how oral feedback was used with individuals/small groups/whole class situations. How each of the different teachers employed oral feedback with the students in their classrooms can be seen in Table 6.6.

Teacher	Number of Success Criteria Interactions Across All Lessons		Number of *Discrepancy* feedback Interactions Across All Lessons		Number of Open Question Interactions Across All Lessons	
	Whole Class	Small Groups/ individuals	Whole Class	Small Groups/ individuals	Whole Class	Small Groups/ individuals
Belle	42	10	1	9	40	17
Charis	24	12	3	42	37	41
Dillon	14	3	4	24	56	130
Eric	44	21	17	19	58	101
Flora	33	13	9	19	42	26
Garry	26	27	0	32	10	118
Henry*	13*	10*	1*	11*	23*	36*
Isobel	16	17	0	19	18	6
Jacob*	36*	1*	5*	2*	29*	4*
Kris	34	5	2	12	6	34
Total for Each Preference	**8**	**2**	**1**	**9**	**4**	**6**

Table 6.6 Whole-class and small group oral feedback practices

* Observed for three lessons rather than four; numbers highlighted in yellow indicate most frequent practice observed for each teacher for each type of oral feedback.

In their initial interviews, nine out of ten of the teachers, with Jacob being the exception, stated that their preference for engaging in oral feedback would be with small groups or individual students. It is worth noting that for the teachers in the study, *discrepancy* information formed part of their conceptualisation of feedback, whereas interactions related to success criteria did not. Interestingly, analysis of teachers' practice aligns with their perceptions only when looking at how they utilised *discrepancy* feedback, with there being a remarkable level of congruity. The idea of fewer cases of oral feedback occurring within whole class settings has been observed previously (Burns and Myhill, 2004). However, Burns

and Myhill (2004) only analysed whole class interactions and do not provide a clear definition of feedback, other than discussing it as part of triadic IRF interactions. In their research, students in whole class settings were observed to mainly engage in talk in response to teachers' questions, with little evidence of discussions in which they could think and learn. In that sense, whole class talk was "being used by the teachers for 'teaching' rather than an instrument for learning" (Burns and Myhill, 2004, p. 47). Such classroom interactions are conducted in an inauthentic way, as the teacher knows answers in advance, in order that classroom conversations are made to "appear more like a dialogue than a monologue" (Ruiz-Primo & Furtak, 2007, p. 60). Consequently, such whole class teaching practices link to the transmission of information model (Burns and Myhill, 2004; Ruiz-Primo & Furtak, 2007), and behaviourist views of learning and feedback. However, even though previous research states oral feedback is more likely to be undertaken in small group/individual interactions (Burns & Myhill, 2004), as demonstrated in Eric's vignette (see section 6.5.1), interactions that involve oral feedback can and were undertaken with the whole class of students.

Consequently, teachers who utilise *discrepancy* feedback only as part of their interactions with small groups and individuals are potentially limiting learning opportunities for the whole class when understandings can be developed in the social context of the science classroom; these are key components of effective learning in science aligned to sociocultural constructivist theories (Agarkar & Brock, 2017; Alexander, 2014; Driver et al., 1994; Harlen et al., 2015; Harrison, 2015; Heritage, 2010; Kapon, 2017; Leach, 1998; Leach & Scott, 2003). Engineering learning environments in which the thinking is made public to all students can benefit all learners in the classroom (Black et al., 2002). By maximising such learning opportunities with everyone, from insights gained from interactions with small groups or individuals, teachers are afforded a way to counteract the main barrier that they identified in conducting oral feedback, which was having the time to interact with every student.

Conversely, it appears that teachers in this study were more likely to discuss success criteria with the whole class. When discussing their conceptualisation of what feedback meant to them, it was noted that teachers did not allude to interactions regarding success criteria. Rather, their definition of feedback focused on what the student had achieved (*progress* information) and what they needed to do to improve (*discrepancy* information). The teachers' definition when compared to the feedback dimensions proposed by Hattie and

Timperley (2007) (see Figure 2.3) therefore aligned with two of the three elements, with the teachers' definition including notions regarding Hattie and Timperley's (2007) feed back (How am I going? What progress is being made toward the goal?), and feed forward (Where to next? What activities need to be undertaken to make better progress?). However, teachers did not include the idea of feed up (Where am I going? What are the goals?), and in this sense the definition which has emerged from them differs from the literature review and that of the students. Analysis of teachers' conceptualisation highlighted that the foci of feedback for six of them related to lower levels associated with tasks (Hattie & Timperley, 2007; Kluger & DeNisi, 1996, see section 2.7.3). Therefore, reasons why teachers' small group/individual discussions were less likely to be related to the learning may be concomitant with their perceptions of what students are aiming to improve. The analysis of teachers' oral feedback practices affords insights into opportunities for maximising the utilisation of sociocultural learning across the whole class of students. The following section 6.4 looks briefly at the extent of commonality that existed between the teachers in terms of their most common oral interactions.

6.4 Notable Aspects of Teachers' Use of Other Oral Interactions

Along with questioning, the most frequent oral interactions undertaken by the teachers were directive teaching, and praise/punishment, all of which made up approximately 77% of all of the oral interactions that occurred during the study. As discussed in section 2.8.2, directive styles of communication are associated with adults telling students what to do rather than facilitating discussions, are coupled with transactional information that is unidirectional, and link to a behaviourist conceptualisation of learning (Bruner, 2001; Tunstall & Gipps, 1996). For this study, the types of oral interactions that come under the *directive* teaching umbrella occurred when the teacher gave task instructions, provided the answer or directly gave the science explanation to the students.

Analysis of the oral interactions undertaken between teachers and students shows that the most common oral interaction was directive teaching, in particular giving task instructions. Indeed, this was amongst the most dominant oral interaction type for every teacher. These findings concur with findings from a study of five secondary science teachers where teacher-led dialogue or answers to student questions were the most dominant forms of teacher talk identified (Wilson, 1999). However, as the current study was undertaken with science teachers who due to the nature of the subject, have to engage in talk regarding practical work, including aspects related to health and safety issues, it is reasonable to expect

considerable amounts of directive teaching especially associated with giving task instructions. Nonetheless, such practices are contrary to the notion of effective learning in science, where constructivist approaches to teaching are reported as being beneficial to students' learning (Agarkar & Brock, 2017). As such, these types of oral interactions are less likely to enable students to demonstrate the attributes cited as being effective for them to undertake during feedback (see section 2.9.1). Indeed, students did not cite any of these oral interactions as those they perceived helped their learning. Therefore, the responses from students in this study echo the findings of others, who attest that rather than *directive* methods, an interactive undertaking provoking students to act more *dynamically* as co-agents during feedback, with students active, and drawing on constructivist approaches, is more beneficial for their learning (Black & Harrison, 2004; Blanchard, 2008, 2009; Dann, 2018; Hargreaves, 2013, 2014; Hattie & Timperley, 2007; Torrance, 2012; Vercauteren, 2009). The prevalence of directive teaching may indicate a predominance of the authoritarian teacher utilising behaviourist approaches. This therefore affords an opportunity for changing the foci of oral interactions in science classrooms to one that better supports constructivist approaches to learning, especially learning in science.

From the comparative analysis the teachers who utilised more oral feedback types in this study were Eric, Garry and Dillon (see Table 6.3). It would be expected that teachers who utilise more of the oral feedback types are likely to engage in less directive teaching, for the reason that only a certain number of interactions can be undertaken within any given lesson. However, the analysis of the distribution of teachers' oral practices (Figure 6.1) does not match directly the pattern; nevertheless, Eric, Garry and Dillon are again shown to be more likely to conduct oral feedback interactions with their students. This data suggests that teachers who were more likely to engage in oral feedback interactions with their students were less likely to be directive in the classroom.

The final point of note with regards to differences between the teachers' use of other oral types, is linked to the frequency of praise/punishment interactions. Belle was the only teacher for whom this oral interaction was in the top three most frequent types utilised in the classroom. Every teacher in the study provided praise and/or punishment within every lesson to varying degrees. However, contrary to other research where praise was noted as a prevalent oral communication undertaken in classrooms (Gamlem & Munthe, 2014; Knight, 2003; Zahorik, 1968), this was not the case for the teachers in this study. A point that accords with that

made by Black and Wiliam (1998b), who claimed the most effective teachers actually praise less than average. Praise, as a communication that supports students' learning has been fiercely deliberated in the literature. There are many who claim that praise may be counterproductive and have negative effects on students' learning (Dweck, 2000; Gamlem & Smith, 2013; Hattie & Timperley, 2007; Hattie & Gan, 2017; Hymer, 2017; Kohn, 1999). The view of students in this study regarding praise accords with those who argue against its efficacy in helping learners, as for the students, praise was not perceived as a key oral interaction that supported their learning. Therefore, in terms of the conceptualisation of feedback for this study, praise is not classified as a type of oral feedback.

This section has focused on the two most dominant non-feedback oral interaction types, directive teaching and praise/punishment, and shown that even though there was congruence between the teachers in terms of their common oral interaction types, the distributions of these varied from teacher to teacher (see Appendix 17). Both directive teaching and the use of praise are coupled with transactional information that is unidirectional and link to a behaviourist conceptualisation of learning with students as *passive* recipients (Askew & Lodge, 2000; Bates, 2016; Bruner, 2001; Buhagiar, 2005, Hargreaves, 2014; Nicol and Macfarlane-Dick, 2006,Tunstall & Gipps, 1996). As such these types of oral interactions are less likely to enable students to demonstrate the attributes cited as being effective for them to undertake during feedback (see section 2.9.1). Therefore, although there were some similarities, each of the teachers operated differently within their classrooms, and it is interesting to note that the teachers who used oral feedback in their lessons were those who were less likely to draw on behaviourist approaches to teaching.

The next section is a synthesis of teachers' oral practices, linked to divergent and constructivist pedagogical approaches, evidenced from the classroom observations and relevant to the aim of this study.

6.5 Teachers' Divergent Oral Interaction Practices

What became evident from the analysis of teachers' practice were not only the *frequency* of their use of the oral feedback types, identified from students' perceptions and the conceptualisation of feedback presented in this study, but also *how* they utilised them with their students and the behaviours they subsequently engendered in them. These additional aspects of how teachers operate within their classrooms provide insights that are relevant when compared to the literature

relating to students' learning in science (see Chapter 2, section 2.4) and align to the ideal typical divergent (and convergent) approaches to learning and feedback (see section 2.5.1). The following sections will examine some of these additional facets of teachers' practices in order to illuminate and contribute to the educational world's knowledge about what goes on in science classrooms and how likely these practices are to encourage/inhibit learning. Consequently the next aspect of the teachers' oral feedback practices examined relates to how they facilitated dialogue within their classrooms.

6.5.1 Sociocultural Learning Environments

An aspect of classroom practice linked to oral interactions and learning, especially learning in science, is aligned to how teachers establishing a socio-cultural and divergent learning environment (Driver et al., 1994; Hardman et al., 2008; Harrison, 2015; Torrance & Pryor, 2001). A key aspect of oral practices evident in science classrooms is the undertaking of well-managed classroom dialogue (see section 2.4.3), and dialogic approaches along with feedback interactions, which open up thinking and help learning (Driver et al., 1994; Harrison, 2015). To reiterate the five key principles of dialogic teaching which are part of a sociocultural approach to science learning are: collective; reciprocal; supportive; cumulative; purposeful chains of dialogue, which teachers plan and facilitate with particular educational goals in view (Alexander, 2014).

Brief but representative vignettes have been selected from the 38 hours of lessons recorded to illustrate the different sociocultural learning environments discerned. The two vignettes are indicative of the different ways that oral interactions were conducted by these two different teacher categories:

1. Teachers who developed sociocultural learning environments, and engaged in more oral feedback interactions and utilised more dialogic approaches.
2. Teachers who developed behaviourist learning environments, and engaged in more directive and closed questioning interactions and utilised more triadic approaches.

Category 1 Vignette – Eric, Lesson 1

Eric has had the class working in pairs with partners looking at questions and having to explain to each other how an acidic buffer works. Eric circulated and discussed ideas with students and has just stopped the class and asked them to indicate how confident they are with their explanations using thumbs up, down or flat. A whole class interaction then takes place.

Eric: Frank you've got two thumbs up so I am going to direct a few pointed questions at you, ok.

Frank: Ok.

Eric: Frank if I wanted to make an acidic buffer, and can we have everybody engaging with this please to make sure we are all on track because we need this for our learning today, what would I mix together Frank?

Frank: Err weak acid and the salt of the weak acid.

Eric: Ok so can you exemplify that?

Frank: Erm like an example?

Eric: Yeah if you exemplify it with an example that would be awesome.

Frank: Err we can use ethanoic acid and sodium ethanoate as the salt of the acid

Eric: Ok, so Frank why do, over here especially listen up. Frank why do we have to add the salt of the ethanoic acid?

Frank: Err so if a H^+ reacts then we get lots of A^- to react with the H^+ so the pH won't be changed because the H^+ will increase or decrease.

(Eric drew on the board $H^+ + A^- \longrightarrow$ *whilst Frank spoke)*

Eric: So you're saying that we're adding the extra A^-, where did the A^- come from Frank?

Frank: From the salt.

Eric: So we are adding the extra A^- from the salt to remove any additional H+ that's in there because you're saying that the H^+ will react with the A^-, to remove the H^+?

Frank: No, yes to remove the extra added H^+.

Eric: And does that explain the buffer action?

Frank: Yeah because then the H^+ that was originally in the solution hasn't been changed so the pH will always stay the same.

Eric: Joe was that like blah, blah, blah?

Joe: Yes, I don't really understand it that well.

Eric: Did Frank try and explain this to you before?

Joe: Yeah and I understood it to a point.

Eric: Ok can you articulate what you weren't getting?

Joe: No.

Eric: No ok, I'm alright with that Joe as long as we get there in the end, it's a journey.

(Eric, when the students were later given an activity to do went and worked with Joe).

Comment: Alexander (2014) describes a number of different characteristics that will be indicated in dialogic teaching episodes involving teacher-student interactions. Some of these characteristics, which were exemplified in Vignette 1 with Eric, include:

- *Cumulative* - Questions asked which are structured so as to provoke thoughtful answers, and further questions that build dialogue with exchanges chained into coherent lines of enquiry. Chains of interactions are built of a series of I-P-R-P-R-P-R- exchanges (Scott, Mortimer & Aguiar, 2006). This can be seen when Eric spent time probing Frank's understanding, utilising questions that were anchored in the content of the lesson and prompted and challenged Frank's thinking and reasoning.
- *Collective and Reciprocal* - Students being encouraged to participate and provide explanations, rather than the teacher doing so. This occurs when Frank is repeatedly encouraged to provide the explanation of how acid buffers worked, and then Eric brings Joe into the discussion.
- *Reciprocal and Purposeful* - Encouraging those who are not speaking to actively listen. This occurs when Eric asks students in the class to *'Can we have everybody engaging with this please to make sure we are all on track',* indicating that this is important to listen to for their learning.
- *Supportive* - Students feeling confident to air their thinking and make mistakes. This is evidenced when Eric engages Joe in the discussion and

Joe is happy to share in front of everyone that he only understands the explanation to a point.

This vignette not only exemplifies how the content of the oral interactions involved Eric engaging students in discussing ideas around what the learning goal and success criteria were for test questions that were associated with the use of buffer solutions, but in addition demonstrates how the classroom talk that was dialogic in nature, engendered sociocultural learning opportunities for the students. Incidents similar to the one exemplified by Eric were common across the teachers who utilised more of the oral feedback types perceived to support learning, therefore indicating how the substance of the interactions was accomplished by employing dialogic teaching mechanisms. Such approaches align with divergent practices and constructivist theories, thought to be more beneficial to students' learning in science (see Chapter 2).

Category 2 Vignette – Isobel, Lesson 4

Isobel is getting students to draw graphs, and before they proceed with the activity she stops the class to discuss expectations and write them on the board under the title 'Science Graph Rules'. A whole-class interaction then takes place.

Isobel: 'Right, what are the four rules of drawing graphs for science, ok?'

Student calls out: 'Use a pencil.'

Isobel: 'OK, not part of the rules so I'll stick that on the side.'

(Isobel writes 'pencil' on the side of the board)

Student calls out: 'Using a ruler.'

Isobel: 'Using a ruler aren't (sic.) in the rules that get you marks but they are useful, so I will put that there ok.'

(Isobel writes 'ruler' on the side of the board)

Isobel: 'What are the four things that we expect, that you need to have?'

(No one responded, Isobel continued)

Isobel: ‘What about the x and y axis?’

Student calls out: ‘Label them.’

Isobel: ‘Label.’

(Isobel writes ‘x axis’ and ‘y axis’ on the board, and adds the word ‘label’ after each under the title ‘Science Graph Rules’)

Student calls out: ‘Title.’

Isobel: ‘Title actually doesn’t get you a mark in the actual exam but useful.’

(Isobel asks class to be quiet and writes ‘title’ on side of board)

Isobel: ‘Apart from labelling your x and y axis what else do you need to have on them?’

Student calls out: ‘Labels.’

Student calls out: ‘Unit.’

Isobel: ‘You need to have your units and your values.’

(Isobel adds ‘units’ and ‘values’ next to ‘x axis’ and ‘y axis’ on board under rules)

Isobel: ‘Right, so at this point we have something that looks …’

(Isobel then draws graph axes on the board.)

Isobel: ‘How do you work out your scale?’

Student calls out: ‘Don’t know.’

(Isobel asks class to be quiet)

Isobel: ‘Does anyone know how to work out what’s a sensible scale for their graph?’

(No one responded, Isobel continued to speak)

Isobel: ‘Easiest way, largest value for time we have got here is 55 seconds. So work out how much space that you have got along the, which axis does time go on?’

Student called out: ‘Bottom.’

Isobel: ‘Work out how much space you've got, i.e. how many squares you have got and divide it nicely, so let’s say 60 so it’s nice easy numbers to do it, so therefore work it out. So for the other one 994 it’s just under a thousand so work out how many squares you’ve got so it goes easily up here. How big should your graph be on your piece of paper? So if you’ve got a piece of paper*.’*

(Isobel shows an example to students)

Isobel: ‘Is that acceptable for your graph?’

Student calls out: ‘No.’

(Isobel shows another example to students)

Isobel: ‘Is that acceptable for your graph?’

Student calls out: ‘Yes, no.’

Isobel: ‘It has to be over half the size of the piece of paper, so I am expecting a graph either like that or if you are doing it landscape like that.’

(Isobel then draws on board two graphs and adds words ‘over half page’ to rules)

Isobel: ‘So over half the page. And then the last one is accurate plotting.’

(Isobel adds ‘accurate plotting’ on board under rules).

Isobel: ‘And then the very, very last one, best fit.’

(Isobel then circulates around the class supporting students whilst they draw their graphs)

Comment: As discussed earlier, triadic patterns of oral interactions have been shown to be dominant during teacher-student dialogue (Lemke, 1990; Wilson, 1999). With the triadic interactions following either the IRF or IRE pattern (I corresponds to the *initiation* of the dialogue by the teacher, normally with a question; R is the student's *response*; and F is the *feedback* from the teacher or *E* teacher *evaluation*) (Cazden, 1986; Cazden & Beck, 2003; Edwards & Mercer, 1987; Mehan, 1979; Sinclair & Coulthard, 1975; Viiri & Saari 2006). This vignette

consisted of a series of short burst IRF and IRE exchanges, and exemplifies how Isobel employed both:

- IRF interactions: when Isobel, on a number of occasions, asked the whole class the question about what the four rules for drawing graphs in science were, and students called out answers. Isobel subsequently went on to give the students the answers; e.g. when discussing the size that the plotted graph should be.
- IRE interactions: when Isobel on a number of occasions asked the whole class the question about what the four rules for drawing graphs in science were and students called out answers that were incorrect. Isobel then proceeded to tell the students that the answers were incorrect and visually put them to an aside.

This vignette shows Isobel discussing with her students the success criteria for drawing a graph, however, it is managed in a very different way to that exemplified previously by Eric. Isobel uses questions in an inauthentic way to make classroom conversations appear more like dialogue than monologue (Ruiz-Primo & Furtak, 2007). This is in contrast to Eric, who 'opened up' and made thinking public (Black et al., 2002) to the whole class, as they co-constructed feedback as a dialogue formed by loops between the teacher and the students (Askew & Lodge, 2000). Isobel uses interactions regarding success criteria in a convergent way, where feedback involves the teacher as the 'expert' providing information as a 'gift' to the students to help them improve (Asker & Lodge, 2000). Moreover Isobel's vignette highlights the link between the triadic patterns of dialogue employed and the teachers who utilised more convergent practices and behaviourist approaches to learning in science. These vignettes demonstrate that it is not only the use of oral feedback interactions in the classroom that can support learning but also *how* these various types are utilised as part of the feedback process that is important.

One final aspect associated with oral practices is examined. This explores divergent practices where teachers shifted the locus of responsibility to the students and supported them in becoming independent and *dynamic* co-agents of their own learning. This is discussed in the next section, with a final synthesis of the makeup

of teachers being presented after their classroom practices have been compared to their conceptualisations.

6.5.2 Promoting Student-directed Learning and *Dynamic* Student Behaviours

In Chapter 4 it was indicated that for some of the teachers a further aspect of oral interactions was identified linked to their perceived feedback practices, and subsequently the behaviour of students they affect within the feedback process. These teachers specifically perceived their role during feedback was to encourage *dynamic* student behaviours by promoting student-directed learning. This list of teachers who cited in both their feedback definition and perceived practices the promotion of student-directed learning was: Belle, Dillon, Eric, Flora and Garry (see Figures 4.1 and 4.2). As Dillon articulated, this approach to oral feedback was to establish an:

> *Interactive … coaching style particularly with the groups I teach. It's not I've got all the knowledge and you're the empty vessel model. I tend to use the coaching model and get the students to come up with the answers themselves eventually'. (Initial Interview)*

In addition to teachers citing the promotion of student-directed learning as an aspect of their feedback practice repertoires, in Chapter 5 students also referenced this oral category as a feature of teachers' oral classroom practices perceived to support learning. Therefore, both students and teachers in this study have identified this additional oral interaction perceived to be beneficial to students' learning. This oral type was not classed as feedback when compared to the conceptualisation of feedback derived from literature, as it did not involve directly discussions related to learning goals. However, it is a useful source of information obtained from a teacher as it provokes students to take charge of their learning, and shifts the locus of responsibility so they work independently of the teacher, and continue with their work either on their own or with peers. Consequently, promotion of such behaviours may result in feedback being generated with an alternate agent to the teacher, including the learners him or herself. This notion of feedback being derived from multiple agents agrees with ideas suggested by others (Hattie & Timperley, 2007; Shute, 2007, 2008; Voerman et al., 2014), and qualifies the

feedback definition proffered by this study. Examples of such oral interactions were:

> *'I know it's difficult to put into words but I want you to think about it'. (Charis, Lesson 2)*

> Joseph: *'How much of that do we need?' (Asked to teacher during practical when student had to make a standard solution).*
>
> Flora: *'You've got to work that out' (Flora walked away and left student to do work). (Flora, Lesson 1)*

Teachers promoting student-directed learning, provoking them to work independently so they become responsible are aspects of teacher feedback practices thought to benefit learning (Carnell, 2000; Dann, 2018; Hargreaves, 2013, 2014; Hargreaves et al., 2000; Nuthall, 2007; Schwartz, 1980; Vercauteren, 2009; Voerman et al., 2014; Watkins et al., 2002, 2007, see section 2.8). These types of oral interactions were observed in the classrooms of all the teachers to differing extents. Table 6.7 is the resulting synthesis across the teachers of how often they promoted student-directed learning during oral interactions with their students. Teachers are listed in order from those that provoked students to work independently the most, to those who did this the least.

Table 6.7 Teachers' promotion of student-directed learning

Teacher	Number of Instances of Promotion of Student-directed Learning As A Percentage of All Oral Interactions for Each Individual Teacher
Garry	47 (8.01%)
Henry	25 (4.95%)
Kris	13 (2.16%)
Isobel	15 (1.88%)
Eric	11 (1.71%)
Flora	8 (1.23%)
Dillon	7 (0.80%)
Charis	5 (0.73%)
Belle	8 (0.72%)
Jacob	1 (0.21%)
Total Number of Promotions of Student-directed Learning Across All Lessons and as a Percentage of All Oral Interactions	140 (2.02%)

In section 2.9 when discussing the role of students in feedback, it was noted feedback becomes more effective when it moves students from being *passive* recipients to *dynamic* co-agents in the process, achieved by teachers working with learners to enable them to make qualitative judgements in order to build students' own evaluative knowledge. These types of oral interactions result in students behaving in a way that enables them to engage in a more purposeful way in the feedback process. They are not only provoked to be more cognitively responsible but enabled to become involved in the monitoring and generation of evaluative information; i.e. they begin to identify next steps and see what they need to do in order to develop learning, consequently building build self-regulating capacities (Blanchard, 2008, 2009; Black et al., 2002; Sadler, 1989). Activating student self-assessment capabilities can produce extraordinary improvements in achievement, with the most important element appearing to be the notion of self-regulation i.e. students monitoring and evaluating their own learning (Wiliam, 2011).

Both *dynamic* and *passive* oral interactions were observed across all the teachers as they utilised the oral feedback types in differing ways with their students. Both of these different ways of interacting with students during oral interactions can be aligned to differing assumptions of learning. The examples below are indicative of these different types of exchanges.

An example of a *dynamic* teacher-student oral interaction:

Whilst carrying out some practical work in a lesson, a student spots that the results they are getting are not showing the pattern they expected.

Phil: 'Sir I don't think I've done it right, I think it might be a bit wrong'.

Garry: 'Why?'

Phil: 'I don't know'.

Garry: 'So what are you going to do?'

Phil: 'Sulk. No, I need to charge it all up again and I need to start again and turn the wires around. I really don't see the point.'

Garry: 'Of what?'

Phil: 'This experiment'.

Garry: 'Well the point of the experiment is to gather results and to be able to do the section B paper, and overall in the long term is to teach you the skills of how to carry out an experiment. Already you have noticed that is not fitting a pattern, not everybody can do that, you have actually used your judgement to say that is not correct and I need to start again. That's good.' (Garry, Lesson 3)

The teacher in this interaction asks the student open questions, and makes the student identify what they need to do to improve the data they have collected. They then conclude by describing the behaviours that this experience is developing in the student that will be transferable to future learning. The teacher works with the student in this example in a *dynamic* way, as they draw on divergent practices to guide and support the student. The teacher does this by working with the student, enabling them to think and generate the evaluative knowledge in order to ascertain for him or herself how they will proceed. The teacher promotes student-directed learning as the student is then left alone, and acts independent of the teacher by repeating the experiment in order to collect better data from which to draw conclusions.

An example of a *passive* teacher-student oral interaction:

Whilst writing up conclusions after having carried out some practical work in a lesson, a student is having difficulties in critiquing the procedure undertaken.

Heather: 'What should I say Miss about the problems [with the experiment]?'

Charis: 'So just say it wasn't a perfect experiment to carry out, which could have lead to these anomalies.'

Heather: 'So it wasn't a perfect experiment'

Charis: 'Yes, but this does relate well to what happens in real life with earthquakes because they are unpredictable aren't they, and that could be because the rocks are jagged and it is difficult to overcome the friction between them.'

Heather: 'Miss, I've put for my primary error it couldn't have been a perfect experiment because there could have been issues with the elastic band?'

Charis: 'With pulling it, it's the amount of force you use isn't it'. (Charis, Lesson 4)

The teacher in this interaction provides the student with direct answers regarding where the issues were with the experimental procedure, and gives ideas of how the experiment links to everyday life. The teacher engages the student so they behave in a *passive* way as they draw on convergent practices. They do this by removing the opportunity for the student to think, evaluate and ascertain for him or herself how they will proceed, as they give them the specific answers needed to improve their work. The student is reliant on the teacher, and subsequently acts and completes their conclusion using the teacher's answers.

From these two examples, the nature of the different behaviours of the teachers and students in *dynamic* and *passive* oral interactions can be seen. *Dynamic* and *passive* feedback interactions align to the divergent and convergent ideal-typical approaches proposed by Torrance and Pryor (2001), and the differing underpinning learning theories. However, as Torrance and Pryor (2001) noted these two approaches are not necessarily mutually exclusive, and evidence of both

passive and *dynamic* oral interactions did occur across all of the teachers throughout their lessons.

Sadler (1989) argued that if the evaluative information was derived from the teacher then the interaction would be classed as feedback. However, Sadler's (1989) conceptualisation of feedback involves the teacher acting as the giver of the evaluative information imparted as a gift to the students (Askew & Lodge, 2000), with such feedback interactions affiliated with behaviourist theories. These were the types of convergent interactions observed when students behaved as *passive* recipients during feedback, and occurred when the teacher was engaged in *discrepancy* or success criteria interactions by providing the students with the ideas for how they should proceed. However, teachers in *dynamic* divergent oral interactions supported students to be their own source of evaluative information. Students were observed to engage in the feedback process with a more equal power dynamic between themselves and the teacher, with both working together to construct meaning, make connections and gain new insights (Askew & Lodge, 2000). Such practices are associated with constructivist theories and indicate how students are capable of operating as a source of evaluative information, with appropriate teacher support in the process.

An over reliance on evaluative judgements made by the teacher is not beneficial for learners (Sadler, 1989). Therefore, the promotion of *dynamic* student-directed learning involving teachers and their students drawing on divergent practices is important if learners are to develop the understanding they need to eventually "become independent of the teacher and intelligently engage in and monitor their own development" (Sadler, 1989, p.141). This does not mean that the teacher's role is redundant during feedback, as students develop self-monitoring and self-regulated approaches. On the contrary, the relationship seen was very much a *dynamic* and interdependent one, with teachers knowing how and when to challenge and enable students in order to maximise their learning. Indeed "the guild knowledge of teachers is less in knowing how to evaluate student work and more in *knowing ways to download evaluative knowledge* to students" (Sadler, 1989, p. 141). Consequently, being able to undertake such oral interactions in which student-directed and *dynamic* behaviours are developed takes a great deal of skill and guild knowledge on the part of the teacher.

Consideration of the use of oral interactions and the promotion of student-directed learning indicates the practices employed by the different teachers.

Practices that engender students' autonomous capabilities, enabling them to become more active in evaluating and identifying next steps, align with those indicated to be more beneficial for learning (Gipps, et al., 2000; Hargreaves, 2011, 2017; Kulhavy & Stock, 1989; Shute 2007, 2008; Torrance & Pryor, 2001; Tunstall & Gipps, 1996, Tunstall et al., 1996, see Table 2.4). Teachers who promoted student-directed learning were drawing on divergent approaches linked to constructivist views of education as they were working with the student, giving them cognitive responsibility through a two-way bi-directional exchange of information as a "*dynamic* generative process" (Plank et al., 2014, p. 107), with teachers and students learning from each other and action required from both parties (Dann, 2018; Vercauteren, 2009). Such teacher practices are important in science if constructivist approaches to teaching are to be used to enable students to become responsible for deepening their understanding of complex ideas and phenomena and motivated to do so (Agarkar and Brock, 2017; Bryson & Hand, 2007; Harrison, 2015; Harlen et al., 2015; Leach & Scott, 2003). This deeper learning may enable students to apply ideas in multiple and complex situations, a quality that they very much need in the changing world and with the current science curriculum.

Students operating independently and in a *dynamic* way may not be achievable for all ages. Bryson and Hand (2007) conducted research with students based in higher education, where individuals in such institutions are often expected to work in such ways. However, Bryson and Hand found that "for some students autonomous learning offered exciting new horizons but others were much more fearful and were alienated by this" (2007, p. 359). This may account for why some of the teachers used fewer of the 'promotion of student-directed learning' oral interaction type than others, due to the age of their students; e.g. all of Belle's lessons were with Year 7 students (see Section 3.5.1 for details of teachers observed classes). However, there are examples of previous studies in which younger students in primary classrooms have cited similar teacher practices as beneficial in developing their autonomous capabilities and learning (Dann, 2015a; Hargreaves, 2012, 2013, 2014; Murtagh, 2014), indicating this is a potential practice teachers can undertake to benefit all learners in science classrooms.

In light of the findings relating to oral feedback types linked to students' perceptions, alongside the more distributed model of learning and feedback observed in science teachers classroom practices and debated as being beneficial for students, (Askew & Lodge, 2000; Buhagiar, 2005; Gipps et al., 2000; Hargreaves, 2012, 2013, 2014, 2016; Nuthall, 2007; Torrance & Pryor; 2001;

Tunstall and Gipps, 1996; Voerman et al., 2014; Watkins et al., 2002, 2007) the theoretical definition of feedback needs to be updated in order to exemplify constructivist theories, and make explicit the notion of students acting within the feedback process in a *dynamic* way, rather than passive recipients. In addition, as this study was conducted within science classrooms, a further example of a useful source of information can be added relevant to applied subjects; namely, practical work. Therefore, the updated definition of feedback conceptualised by this study is:

Useful information generated with an agent (teacher, peer, book, parent, self or personal experience including practical work) which supports learning, relates to learning goals, regarding aspects of one's performance or understanding, and is utilised to improve one's learning of science.

In summary, this study has identified a difference in teacher oral interaction practices evidenced previously. This difference is linked to how teachers empower and enable students to behave within the feedback process, and how they utilise the different oral feedback types within it, aligned to two ideal typical approaches: divergent and convergent (Torrance & Pryor, 2001). From the findings ascertained in this study, a divergent feedback process is more likely to involve co-constructed feedback loops (Askew & Lodge, 2000), sociocultural learning opportunities involving dialogic interactions, and the locus of responsibility being shifted towards the students. This increases student independence and empowers them to behave as *dynamic* co-agents, being sources of evaluative knowledge, co-constructing with the teacher the way forward and most importantly being made to think. Such interactions align with constructivist theories and views of learning, which are thought to be more effective in helping students to learn in science. Conversely, a convergent feedback process sees feedback as a gift provided to the student (Askew & Lodge, 2000), directive forms of teaching, and the locus of responsibility remaining with the teacher. The students are treated and behave as *passive* recipients, with the teacher being the source of evaluative knowledge whilst directing students how to act and doing the thinking for them. Such interactions have roots in a behaviourist view of learning, perceived to be less effective for leaners in science.

In both divergent and convergent interactions, the students are active, as they are required to respond and improve their performance after the oral feedback interaction has taken place. Alongside this, the oral interactions are two-way, as they require both teachers and students to interact with each other. However, these two-way discussions may result in unidirectional information being provided, i.e. from the teacher to the student, rather than a true two-way co-construction in which the students should direct their next actions. Indeed, all three oral feedback types could be used in either a divergent or convergent way. It is therefore not just *what* the teachers discuss with their students, but also *how* they construct these interactions that is important. The next section looks to answer the research question regarding how teachers' conceptualisations of oral feedback matched their practices.

6.6 Comparison of Teachers' Conceptualisation and Practice

This section sets out to explore how teachers' conceptualisation of oral feedback compares to their practice of it in the classroom, along with an evaluation of their use of student-directed learning, which was an oral interaction perceived by students as a beneficial to their learning. Just because a teacher did not mention some of the characteristics identified as improving learning when conceptualising oral feedback does not mean that the teachers did not value, or indeed employ, these strategies in their classrooms. Every teacher employed every feedback and oral interaction type to a lesser or greater extent throughout the observed lessons. However, what can be seen are patterns across the teachers from which comparisons and areas of interest can be gleaned to add to collective thinking about oral practices and how the utilisation of different feedback types and approaches may be beneficial to learners.

- Figure 6.2 - Represents how teachers conceptualised their feedback practices as identified in Chapter 4.
- Figure 6.3 - Represents how teachers were observed to use these oral types in their classrooms. Teachers who were allocated to a section were those who had above average likelihood (with respects to the data analysed) for a utilising a particular oral interaction type.

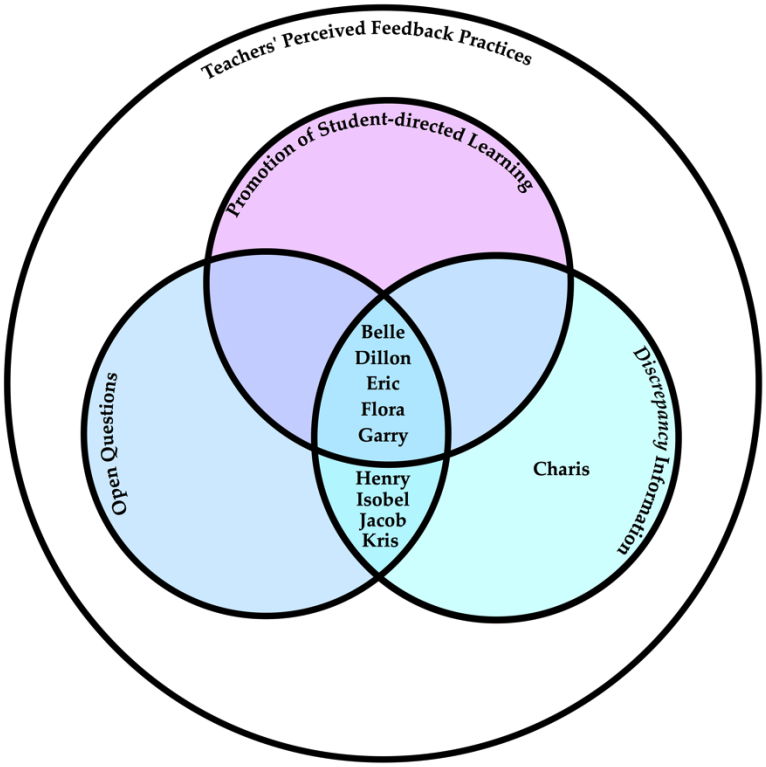


Figure 6.2 Teachers' perceived feedback practices

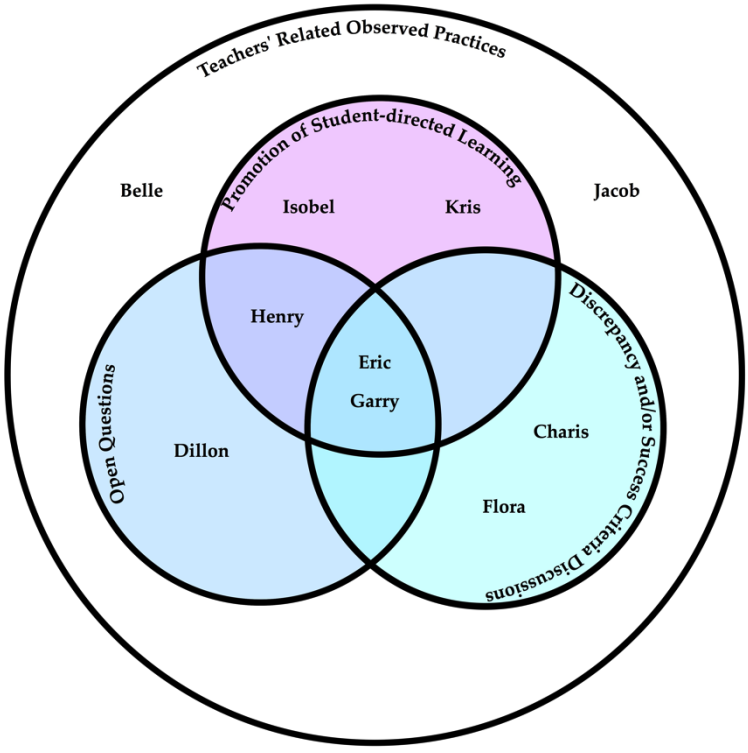


Figure 6.3 Teachers' related observed practices

The named circles in Figure 6.2 were compiled from categories emerging from teachers' conceptualisation of oral feedback (see Chapter 4). However, it is worth noting that in order to undertake a comparison across the teachers from their conceptualisation to classroom practice in Figure 6.2, the segment named '*discrepancy* information' has been altered in Figure 6.3 to reflect the oral feedback types identified during the data analysis, as this encompasses all aspects of oral feedback identified from students' perceptions aligned to the derived conceptualisation presented in this study. The additional aspect of promoting student-directed learning, even though not categorised as oral feedback, has been debated throughout, and is an aspect of oral interactions conceptualised by teachers when discussing feedback practices, and perceived by students as being beneficial to learning and is therefore included.

All teachers employed all oral feedback types at some point across the data collection period. However, from the synthesis, some had an understanding of their own oral feedback practices – Charis, Eric and Gary, whilst the rest had an alternative conceptualisation - Belle, Dillon, Flora, Henry, Isobel Jacob, and Kris. For some, there were fewer or different feedback types implemented in their practice than asserted from their conceptualisation. The findings support earlier studies in which teachers have discussed ideas relating to their practice that have then not been realised in actuality (Chin, 2006; Gamlem & Munthe, 2014; Knight, 2003; Murtagh, 2014; Ruiz-Primo & Li, 2013; Vercauteren, 2009). Reasons for this could be as a consequence of: teachers' lack of clarity with what constitutes feedback and how to use it effectively (Knight, 2003); or teachers needing to have developed their own tacit knowledge to be able to provide guidance related to the higher levels of feedback foci (Sadler, 1989); or teachers underlying beliefs about learning influencing their practices (Agarkar & Brock, 2017; Black & Wiliam, 1998a; Gipps et al., 2000; Hargreaves et al., 2000; Lee, 2009; Hargreaves et al., 2000; Torrance & Pryor, 2001, see section 2.10.1). For the teachers in this study, whether any of these reasons were why there were discrepancies between their perceptions and practice were not investigated further.

In summary, the study was guided by the key aim:

'How science teachers conceptualise and practise oral feedback, and how students perceive it helps their learning'

Three oral feedback types have been identified in conjunction with the conceptualisation of feedback presented, as well as useful sources of information,

all of which were perceived by students to benefit their learning in science. Alongside this, practices associated with two ideal typical approaches to feedback, as well as a wide range of other oral interaction types, were identified that were utilised in varying degrees by the teachers in the study. Figure 6.4 summarises all of the different sources of useful information, oral interactions and oral feedback types identified, in comparison to the theorised conceptualisation of feedback derived from literature.

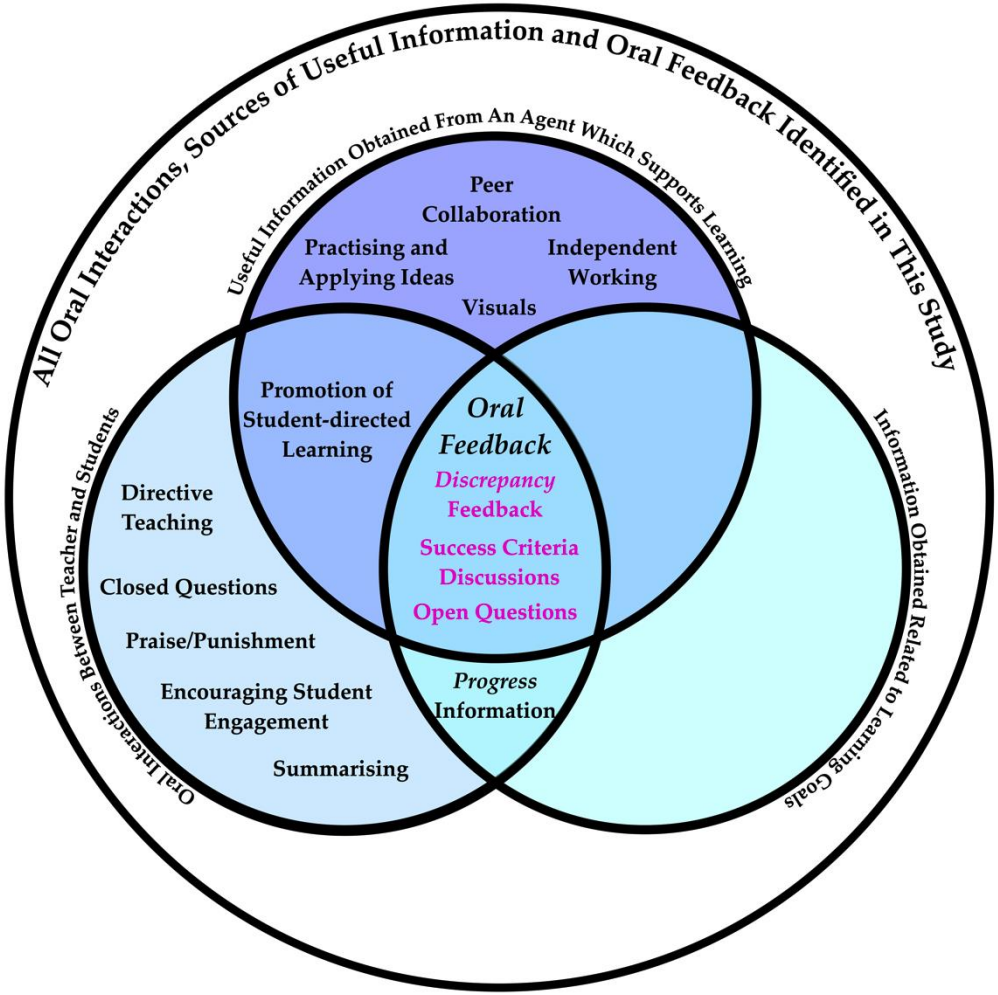


Figure 6.4 Study's oral interactions, feedback types and sources of information

6.7 Chapter Summary

6.7.1 Research Question 4

This chapter set out to answer the research question:

To what extent and in what ways do science teachers' oral interactions compare to their conceptualisation of oral feedback and students' perceptions of what helps learning?

Teachers used the three feedback types: *discrepancy* feedback, interactions regarding success criteria, and open questions to different extents and in differing ways. In comparison to the theorised conceptualisation of feedback, an analysis of the oral interactions undertaken between the teachers and students alongside the synthesis from both regarding their perceptions of what oral feedback types benefit learning, a number of different aspects of teacher practice have been explored. It has been shown that for the teachers in this study:

- Oral feedback interactions were observed much less frequently than other oral interactions. The most frequently observed oral feedback is open questions. Interestingly, the most cited beneficial oral feedback type by the students was *discrepancy* feedback. However, for the teachers this was the least utilised of all the oral feedback types.
- They were more likely to conduct oral interactions related to *discrepancy* feedback with small groups or individuals than they were with the whole class, with the converse observed with their use of success criteria interactions.
- The dominant oral interaction types were directive teaching (i.e. giving task instructions and/or providing answer or the direct teaching of science) and asking closed questions.
- The perceptions regarding how teachers utilised various aspects of oral feedback discussed in Chapter 4 did not in the main match the ways they operated in the classroom, with many using fewer of the oral feedback types than they perceived.

These findings resonate with those identified previously in different environments, with many similarities being identified such as the dominance of

directive teaching, evaluative judgements, closed questioning, and disparity between teachers' perceptions and practice (Alexander, 2014; Bruner, 2001; Gall, 1970; Chin, 2006; Gamlem & Munthe, 2014; Knight, 2003; Lee, 2009; Mercer, 2007; Mortimer & Scott, 2003; Murtagh, 2014; Ruiz-Primo & Li, 2013; Vercauteren, 2009). Such approaches signify a dominance of traditional pedagogical approaches and behaviourist theories aligned to learning.

This study adds knowledge as to *how* teachers utilise oral feedback within science classrooms, along with accompanying practices that may enhance/inhibit learning. A clear definition of feedback has been used, with examples of how it has been operationalised in an observational context provided. It has been discussed how teachers can use the oral feedback types (*discrepancy* feedback (highlighting ideas for next steps, errors or misunderstandings), open questions (asking questions in order to make students think, including not giving answers), interactions regarding success criteria (quality/standards related to goal)) in differing ways with their students, with the differences in feedback practices observed linked to Torrance and Pryor's (2001) divergent and convergent ideal-typical approaches. Different student behaviours have in addition been highlighted, with students empowered to operate as *dynamic* co-agents in the feedback process within the divergent approach, or as *passive* recipients within the convergent approach. The key aspect of the *dynamic* relationship is that the student would be made to do the thinking for himself or herself, whereas during *passive* feedback interactions the thinking opportunity for the student is removed and they are told what to do next by the teacher. Table 6.8 is a theoretical framework for feedback generated by this study linked to Torrance and Pryor's (2001) ideal typical approaches. It is a contribution to knowledge and summarises the different practices identified from the analysis of the teachers operating within secondary science classrooms. Within the theoretical feedback framework, associated learning theories underpinning the ideal typical approaches along with implications are referenced. A note of caution is due here since teachers tended to draw on multiple practices aligned to differing learning assumptions. This is analogous to Torrance and Pryor's (2001) classroom assessment model, signifying that both ideal typical approaches to feedback are not "necessarily mutually exclusive in practice" (Torrance & Pryor, 2001, p. 616). Nevertheless, for teachers one theoretical assumption may dominate as they hold an established structure of knowledge and viewpoints about teaching and learning, consistent with their personal epistemological beliefs (Niederhauser & Stoddart, 2001).

Convergent	Divergent

Feedback undertaken between teacher and student as a uni-directional process with students operating as *passive* recipients of information on which they subsequently act. This is characterised by:
Practical Implications
• Teachers utilising fewer of the oral feedback types and more:
  ○ Directive teaching approaches.
  ○ Closed questioning.
• Teachers more likely to:
  ○ Provide answers or ideas for next steps;
  ○ Conduct a greater number of whole class interactions with students;
  ○ Employ triadic dialogue teaching practices;
• Students being dependent on the teacher
Theoretical Implications
• A behaviourist view of feedback focused on providing judgements in terms of facts memorised, concepts acquired or content mastered;
• An intention to move forward learning to the next predetermined thing in a linear progression.
• A view of feedback as a gift accomplished mainly by the teacher, with the locus of responsibility and cognition with the teacher.
This view of feedback attends more closely to traditional theories of learning and learning in science.
	Feedback undertaken between teacher and student as a two-way bi-directional process with students operating as *dynamic* co-agents generating evaluative knowledge and identifying how they should subsequently act. This is characterised by:
	Practical Implications
	• Teachers utilising more of the oral feedback types (*discrepancy,* success criteria interactions and open questions) and more:
	  ○ Promotion of student-directed learning.
	• Teachers more likely to:
	  ○ Be less directive;
	  ○ Conduct a greater number of small group or individual interactions with students;
	  ○ Employ dialogic teaching practices;
	• Students more likely to work independently
	Theoretical Implications
	• A social constructivist view of feedback focused on the quality of a student's learning or degree of expertise;
	• An intention to develop learning in the zone of proximal development;
	• A view of feedback as loops accomplished jointly by the teacher and student, with the locus of responsibility and cognition shifting to the student.
	This view of feedback attends more closely to progressive theories of learning and learning in science.

Table 6.8 Theoretical ideal typical feedback framework generated by study

The present study raises the possibility that approaches associated with divergent feedback practices aligned to constructivist learning theories, may be more beneficial for students' learning, especially learning in science (Agarkar & Brock, 2017; Harlen et al., 2015; Harrison, 2015; Johnson, et al., 2000; Johnson et al., 1981; Kapon, 2017; Kyndt et al., 2013; Leach & Scott, 2003; Millar, 2004).

Finally, in light of the findings presented in this chapter, the initial conceptualisation of feedback derived from literature, has been shown to align more to *passive* convergent and behaviourist approaches to feedback. Therefore, the theoretical definition of feedback proposed in Chapter 2 has been updated to

make explicit the more distributed model of learning highlighted in the literature as benefitting students when they engage in *dynamic* feedback (Askew & Lodge, 2000; Blanchard, 2008, 2009; Dann, 2018; Gipps et al., 2000; Torrance & Pryor; 2001; Voerman et al., 2014;). The useful sources of information have been expanded to reflect learning in applied subjects, such as science, and include practical work as an example of a useful source of information that helps students learn. Therefore the updated definition of feedback presented by this study is:

Useful information generated with an agent (teacher, peer, book, parent, self or personal experience including practical work) which supports learning, relates to learning goals, regarding aspects of one's performance or understanding, and is utilised to improve one's learning of science.

The theoretical ideal typical feedback framework generated by this study, along with the more distributed conceptualisation of feedback suggested, may help understanding in the field as to how oral interactions that occur between the teacher and their students in lessons can support learning. The findings have important implications for policy makers, practitioners, researchers and those who support educators. In the next chapter the findings from the analysis of the research questions will be discussed, along with implications for future research, professional development opportunities and personal reflections of myself as the researcher.

Chapter 7 Conclusions

This chapter returns to the purpose of this research study and presents its contribution to knowledge regarding oral feedback. The findings will be discussed in relation to the literature, and opportunities for policy makers and practitioners will be considered, along with identification of future possibilities for research. The chapter will close by considering my personal learning whilst undertaking this work.

7.1 Purpose of Study

This study set out to examine what happens 'in the moment' in science classrooms. Although the current study is based on a small sample of participants, the findings provide a greater insight into those aspects of oral interactions occurring between teachers and their students perceived to benefit learning which are noteworthy, establish value and/or add to the knowledge within the field of science education. Using a theoretically derived definition of feedback, and grounded in students' perceptions of what helps them learn, a subset of the oral interactions occurring in the classroom has been classified as oral feedback. In order to be able to answer the research questions there was a deliberate intention to adopt an interpretivist approach and a small-scale enquiry across ten case study teachers was undertaken.

> *Research as an enterprise in looking to provide definitive insights is very hard with humans, the best that can be hoped for is that it can point the way forward with indicators identified (Harrison, 2016).*

When investigating phenomena that involve human subjects, any findings claimed are tentative, and function to provide guidance for others as to aspects that may be of interest to explore further (Harrison, 2016). The findings must be interpreted with caution because teachers tend to draw on a range of practices aligned to differing learning assumptions. Nevertheless, due to personal epistemological beliefs, there is the tendency for one theoretical assumption to dominate a teacher's practices (Niederhauser & Stoddart, 2001). Therefore, even though generalisations are limited, thick descriptions allow trustworthiness so that "the study can provoke in the minds of researchers, teachers and policy makers, further scrutiny of existing traditions of feedback" (Hargreaves, 2013, p. 231).

Consequently, by providing a research account clarifying the context along with the evidence justifying findings, “a powerful and user-friendly summary has been presented, which can serve as a guide to professional action” (Bassey, 2001, p.5).

The purpose of this study was to determine *how science teachers conceptualise and practise oral feedback, and how students perceive it helps their learning.* As discussed in Chapters 1 and 2 the focus has arisen as a consequence of a lack of understanding in the field regarding teachers’ oral feedback practices in secondary science classrooms.

The research questions addressed were:

1. *How do science teachers conceptualise feedback and perceive their feedback practices including oral feedback?*
2. *What characteristics of oral feedback do science teachers perceive as improving learning?*
3. *What types of oral interactions do students perceive as helping learning?*
4. *To what extent and in what ways do science teachers’ oral interactions compare to their conceptualisation of oral feedback and students’ perceptions of what helps learning?*

Learning and feedback are inextricably linked (Wiggins 1997) and an analysis of the research literature related to both was conducted in Chapter 2, centring in particular on learning in science. Two ideal-typical approaches to assessment were presented concomitant with different learning theories and pedagogical practices. A theoretical definition of feedback was then derived from existing literature in order to build understanding when interpreting findings from both teachers’ and students’ perspectives and to provide clarity in relation to a contested term. The conceptualisation of feedback initially derived from literature was:

> ***Useful information provided from an agent (teacher, peer, book, parent, self or personal experience) which supports learning, relates to learning goals, regarding aspects of one’s performance or understanding, and is utilised to improve one’s learning of science.***

Alongside this, various dimensions related to the effective utilisation of feedback were reviewed, as well as teachers' and students' perceptions and roles undertaken by both in the process. The extent to which the study was able to answer these research questions and point the way forward with regards to oral feedback theory will be addressed in the next sections of this chapter.

7.2 Main Feedback Findings

This work contributes to existing knowledge by examining oral interactions, with findings supporting earlier studies on feedback conducted in other educational contexts. Notwithstanding the relatively limited sample, this work offers valuable insights into oral feedback in authentic science classrooms in the UK. One of the more significant findings to emerge from this study, is that the evidence suggests that the differences presented across how teachers' conceptualise and practise oral feedback, are aligned to two ideal typical approaches; divergent and convergent (Torrance & Pryor, 2001), and the associated learning theories. This study has contributed knowledge to the field by developing the work of Torrance and Pryor (2001) to generate a theoretical framework for feedback with practical and theoretical implications indicated.

The study has identified a number of different findings associated with feedback allied to teachers' conceptualisation and practice, and students' perceptions. The study has highlighted that in the main; science teachers' feedback interaction preferences are to communicate with students orally and in one-to-one or small group settings. The teachers perceived such feedback interactions were more effective, as they were able to provide feedback immediately during the lesson, and personalise it to the individual, hence making it more accessible to the learner. The study also found that the main barrier referenced by the teachers was the inability to interact with all students during a lesson.

The study has shown that for the science teachers there was no definitive conceptualisation of feedback across them. Nevertheless, the study has found that generally teachers' conceptualisations of feedback aligned to that derived from literature, with exceptions affiliated to the feedback foci and behaviours teachers fostered in students as part of the feedback process. The lack of a commonly shared feedback definition across participants, accords with previous ideas that feedback is complex, both conceptually and pragmatically (Dann, 2018, Hattie, 2008). Taken together, these results suggest that there is the potential for

translation issues, for those who are involved in supporting science teachers to develop their feedback practices.

The study has identified a number of practices that were identified across the teachers, regarding their perceptions of their feedback repertoires. These practices included providing *discrepancy* information, asking questions and promoting student-directed learning. The results of the study indicate one major exception with regards to teachers' feedback practices and that derived from literature, allied to the importance of learning goals and success attributed to it, as part of feedback interactions. In terms of goal-related feedback, this study has defined *discrepancy* feedback as a model related to information regarding what is yet to be achieved by the learner, whereas *progress* feedback, is information that affords learners the details concerning the progress they have made towards the goals and what has already been achieved (Voerman et al., 2012). Success criteria interactions were described as relating to specific attainments or understandings or to differing qualities of experience (Hattie & Timperley, 2007), and open questions as questions that support students in expressing and discussing their understanding. Thus providing teachers with more evidence of students' thinking, and enabling them to "explore issues that are critical to the development of students' understanding" Black et al. (2002, p.7).

The study has found that students value a number of oral interactions that support learning in science (*discrepancy* feedback, success criteria interactions, open questions), underpinned by the promotion of student-directed learning, but mention these less frequently than visuals (including the value of engaging in practical work in science) or peer collaboration. As a result of comparing the oral interactions identified by students that help learning, to the theoretically derived definition from literature, and defining only those practices that meet both criteria as feedback, the study has identified three types of oral feedback - *discrepancy* feedback, success criteria interactions, open questions, with findings from the study indicating that students perceive *discrepancy* feedback as the most helpful for their learning. The study has found that generally teachers' and students' perceptions of feedback practices were not always well aligned, with one of the more significant findings to emerge from the study being that students valued success criteria interactions, whereas teachers did not mention this as a part of their conceptualisation of feedback, or views of their practice. Conversely, teachers valued *progress* interactions, whereas students did not highlight this type of oral interaction as being one they perceived as helping their learning. Follow on studies

that attempt to look at the impact of oral feedback on learning might shed some light on this finding

The study has found that generally teachers use oral feedback types less frequently than other oral interactions (oral feedback constitutes approximately one fifth of all oral interactions), with *discrepancy* feedback being the least used. The most common oral interactions were associated with directive teaching (giving task instructions and/or answers/direct teaching of science, approximately two fifths of all interactions). The study has shown that for students' *discrepancy* feedback was perceived as the most helpful for their learning. However, findings from the study indicate this was the least used oral feedback type generally across the teachers, with open questions being the dominant oral feedback type used. The study has shown that teachers were more likely to engage in *discrepancy* feedback interactions within small group settings, with the converse true for interactions regarding success criteria. In addition, the findings suggest that teachers' perceptions are in the main, not well aligned with their classroom practice. The research has also shown that teachers use the oral feedback types in differing ways with their students, with behaviours fostered that are perceived to either encourage or inhibit learning.

Taken together, these findings suggest a role for oral feedback, both with regards the types of interactions, as well the way they are executed, in promoting students' learning in science. The study has provided support for further research wishing to examine teachers' oral feedback practices as it has: (1) developed a research instrument for collecting data in classroom settings; (2) contributed to understanding by presenting a theoretically derived definition for feedback from literature. With regards to the research methods employed, the semi-structured interviews with teachers and groups of students, along with the classroom observations, were particularly successful and yielded rich data, the analysis of which formed the basis of Chapters 4, 5 and 6.

The following section will provide a brief overview of the findings of the study and their relation to previous work in these areas in order to see how far the research questions have been answered.

7.2.1 Research Questions 1 and 2 – Findings From Teachers' Conceptualisation in Relation to Previous Studies

The first and second research questions were aimed at establishing an understanding of how teachers conceptualised feedback (especially oral), their

perceived use of it in the classroom, and how this compared to a research derived definition, and discoveries from previous germane studies. In Chapter 4 the findings from the analysis of teachers' conceptions of feedback were presented and it was identified that, in the main, the teachers' definitions linked with the one conceptualised from the literature and presented by this study: specifically that feedback was perceived as a two-way bi-directional exchange of information between both parties, with each learning and students taking action as a consequence (Dann, 2018; Plank et al., 2014; Vercauteren, 2009).

There was noted a difference as to what it was that teachers were hoping to support students in improving. For over half (six out of ten), the purpose of feedback was to support the improvement of task performance, whilst the remainder reported that it was to help improve students' learning from their current point of understanding. These foci ascribed to feedback by the teachers were compared against the different levels discussed by Hattie and Timperley (2007) and Kluger and DeNisi (1996). Those wanting to improve learning affiliated with the higher levels i.e. aiming to developing understanding about learning process and self-regulation, were aligned to constructivist theories and divergent practices (Torrance & Pryor, 2001). Conversely, teachers who indicated that feedback was associated with improving foci associated with lower levels i.e. task performance, were aligned to behaviourist theories and convergent practices. Consequently, these different foci that were identified potentially afforded insights into teachers' different underlying beliefs of learning.

Science teachers' responses identified awareness of their own oral interaction practices, with the main being *discrepancy* information, involving providing ideas of what needs to be done next and/or emphasising errors and/or misunderstandings, along with, and to a lesser extent, *progress* information, which identifies what has been achieved, which is consistent with findings previously ascertained in different settings, contexts and reviews (Black & Wiliam, 1998b; Costa & Garmston, 2017; Gipps et al., 2000; Hargreaves, 2011; Hattie & Timperley, 2007; Shute, 2007, 2008; Torrance & Pryor, 2001; Tunstall & Gipps; 1996; Voerman et al., 2014; Wiliam, 2018).

The noteworthy difference between teachers' conceptualisation of feedback and the definition derived from literature, related to the inclusion of discussions related to learning goals and success attributed to them. As learning goals are perceived to be a vital facet of feedback (Askew & Lodge, 2000; Black et al., 2002;

Brookhart, 2012, Chappuis, 2012; Hattie & Timperley, 2007; Hattie, 2012b; Voerman et al., 2014; Wiggins, 1997, 2012, 2106), the exclusion of this aspect was notable in the teachers' conceptualisations, particularly as it was found to be important for students. One reason for this may be due to the predominance of feedback practices within the current English education system that encourage teachers to provide *progress* and *discrepancy* information as; W.W.W./E.B.I. (what went well/even better if), or two stars and a wish. These practices explicitly involve parties reviewing progress or noting action to undertake to improve in relation to a goal, but do not explicitly discuss what quality would be with respect to the learning goal. Current practices therefore appear to encourage teachers to address the feedback dimensions of 'How am I going?' and 'Where to next' (Hattie & Timperley, 2007), but seem to be lacking with respect to addressing the question related to 'Where am I going?' (see Figure 2.3).

In addition, the findings from this research support previous studies of teacher practices and how they involve their students during feedback. A subset of teachers in this study identified themselves as encouraging *dynamic* student behaviours, empowering students to become self-directed in their learning, by shifting the locus of responsibility and supporting them to act as *dynamic* agents (Blanchard, 2008, 2009) in the feedback process. The remaining group of teachers did not discuss this aspect of the process. This contrasts with the definition of feedback proposed by Sadler (1989) who argues that in order for an interaction to be determined as feedback, the direction of the evaluative information had to move from teacher to student. The views of these two groups of teachers were again aligned to two ideal typical approaches to learning; convergent and divergent (Torrance & Pryor, 2001), with suggested reasons for differences being due to teachers' underlying views of learning (Askew & Lodge, 2000; Black & Wiliam, 1998a; Gipps et al., 2000; Hargreaves, 2012, 2013, 2014; Hargreaves et al., 2000; Hattie & Timperley, 2007; Torrance, 2012; Vercauteren, 2009; Voerman et al., 2014).

Alongside the use of *discrepancy* and *progress* information, and the promotion of student-directed learning, teachers discussed additional approaches they would use as part of their feedback practice repertoires. The supplementary ways that teachers' perceived feedback would be achieved was through the use of questions, together with assessing current levels of understanding, both of which are approaches associated with effective teaching and learning in science (Brookhart, 2012; Dann, 2018; Driver et al., 1994; Driver et al., 2000; Elliott et al.,

2016; Gipps et al., 2000; Hargreaves, 2011, 2012, 2013, 2014; Torrance & Pryor, 2001). Teachers' preference for feedback interactions with students was found to be through using oral feedback with small groups or in one-to-one settings, again adding weight to previous research findings (Gipps et al., 2000), with barriers cited by teachers' to the implementation of oral feedback attributed to time constraints in interacting with all students.

7.2.2 Research Question 3 – Findings From Students' Perceptions in Relation to Previous Studies

Although feedback is an important process in promoting students' learning, it is under researched within authentic secondary classrooms. Therefore, the aim of the third research question was to establish '*what types of oral interactions do students perceive as helping learning'* in a science context related to learning goals, in order to identify any oral feedback types. As co-owners and beneficiaries of the learning process, it was felt that the perceptions of students were important in terms of the research, and vital in establishing oral feedback types and practices that could be of future importance in the field.

From the analysis of students' perceptions alongside the theorised conceptualisation of feedback derived from literature, three oral feedback types were identified: *discrepancy* feedback, success criteria interactions and open questions. These three oral interaction types all form part of the manifestation of the literature derived conceptualisation of feedback in a science classroom. Of these three types of oral feedback, for students in this study, *discrepancy* interactions were cited as being most beneficial for their learning. Previous studies examining students' views have indicated the benefits of both *discrepancy* and success criteria interactions for enhancing learning (Black & Wiliam, 1998b; Carless, 2006; Dann, 2015a; Hattie & Timperley, 2007; Kluger & DeNisi, 1996; Peterson & Irving, 2008; Sadler, 1989; Shute, 2007, 2008; Voerman et al., 2012, 2014; Weeden & Winter, 1999; Weeden, et al., 2002; Williams, 2010). Whereas, the use of open questions as a form of feedback has been debated in the literature, with some claiming that open questions are just a form of instruction (Knight, 2003; Voerman et al., 2012). However, the findings from this study correspond to others who have debated the beneficial use of such questions in feedback (Brookhart, 2012; Chin, 2006; Dann, 2018; Elliott et al., 2016; Gipps et al., 2000; Hargreaves, 2013, 2014; Hargreaves et al., 2000; Torrance & Pryor, 2001). In contrast to teachers' perceptions of feedback, students in this study did not identify *progress* information as beneficial for their learning. This may have been partly due to the very infrequent use of such

interactions by the teachers in the study. Students did, however, indicate the value for their learning of interactions relating to success criteria, an aspect of feedback missing from the teachers' conceptualisation.

"To be effective, feedback should cause thinking to take place" (Black et al., 2002, p. 10). Students' perceptions aligned to this notion, in that they valued being made to think during feedback, notably by not being given answers. Students agreed with the view of a subset of the teachers regarding shifting the locus of control during oral feedback interactions towards the learner. Moreover students identified the importance of *how* they were empowered to behave during feedback. For the students, being provoked to operate as *dynamic* co-agents through the promotion of student-directed learning was cited as important. Students felt that this was achieved through teachers supporting them to think and make quality judgements about their work to resolve the problems they were facing, involving teachers opening up students' thinking, by employing for example, open questions These findings indicate that for the students, divergent, constructivist (Torrance & Pryor, 2001) feedback practices were perceived as more beneficial for their learning. Feedback that is divergent 'is seen as being accomplished jointly by the teacher and the student, and oriented more to future development rather than measurement of past or current achievement' (Torrance & Pryor, 2001, pg. 617), ideas which are consistent with the findings of this research.

The students' perceptions therefore add weight to previous findings in different contexts and settings, in which constructivist theories, be that cognitive or sociocultural, were noted as being more effective for learning, especially learning in science (Blanchard, 2008, 2009; Driver et al., 1994, 2000; Gipps et al., 2000; Harrison, 2015; Hattie & Timperley, 2007; Leach & Scott, 2003; Nuthall, 2007; Torrance, 2012; Torrance & Pryor, 2001; Watkins et al., 2002, 2007). Conversely, oral interactions more aligned to behaviourist theories (directive teaching, praise), were not perceived by students in this study as beneficial to learning, concurring with views of those who argue against the efficacy of such practices (Bruner, 2001; Dweck, 2000; Gamlem & Smith, 2013; Hattie & Timperley, 2007; Hymer, 2017; Kohn, 1999; Tunstall & Gipps, 1996), and as such were not defined as feedback in this study.

The insights gained from the students in this study provide understanding into how oral feedback (*discrepancy* and success criteria interactions and open questions) that helps learning can be manifest in classrooms, and provide useful

indicators as to how teachers can maximise oral feedback interactions between themselves and their students in science lessons in order to promote learning.

7.2.3 Research Question 4 – Findings from Teachers' Classroom Practice in Relation to Previous Studies

Synthesising teachers' and students' perceptions against the conceptualisation of feedback derived from research, provided a lens through which to analyse teachers' classroom oral feedback practices. Consequently, the final research question was to ascertain *'to what extent and in what ways science teachers' oral interactions compare to their conceptualisation of oral feedback and students' perceptions of what helps learning?'*

For teachers in this study, over one fifth of the oral interactions undertaken in comparison to the study's conceptualisation of feedback (*discrepancy* and success criteria interactions, and open questions), were classified as oral feedback. In contrast to the ranking of the oral feedback types obtained from by students, in which *discrepancy* interactions were named as the type perceived to be most beneficial to learning, followed by success criteria interactions and open questions, the most dominant oral feedback used by teachers was open questions, with *discrepancy* feedback being the least frequently employed. Teachers' oral feedback perceptions were observed in the main to be incongruent to the ways they operated in the classroom, with many using fewer of the oral feedback types than they perceived. This disparity between students' perceptions and teachers' practices indicates a potential opportunity for increasing the number of oral feedback interactions that may improve the learning of students in science.

Alongside the comparative utilisation of oral feedback types, it was found that teachers in this study were more likely to engage in *discrepancy* feedback when interacting with small groups or individuals, whereas interactions related to success criteria were more likely to take place within whole class settings. Such insights suggest ways to maximise sociocultural learning opportunities for students. If teachers were able to relate to the whole class aspects of *discrepancies* that they encountered whilst engaging with individuals/small groups, then there is the potential for enhanced learning opportunities in science for all students. This change in oral feedback practices would also afford teachers a way of countering the main barrier they identified in using oral feedback; namely, interacting with every student in the class.

In comparison to the use of different types of oral feedback, the teachers in this study used directive teaching more than any other oral interaction. The findings

are consistent with previous research studies in which the dominance of directive teaching and the deeply rooted staying power of recitation types of teacher talk prevail, along with teachers' misinterpretations of how they operate in the classroom (Alexander, 2014; Bruner, 2001; Gall, 1970; Chin, 2006; Gamlem & Munthe, 2014; Knight, 2003; Lee, 2009; Mercer, 2007; Mortimer & Scott, 2003; Murtagh, 2014; Ruiz-Primo & Li, 2013; Vercauteren, 2009). Alongside this, in environments in which recitation persists, feedback can often regress to the phatic or uninformative (Alexander, 2014). Therefore, it is not surprising that the dominant oral interaction types identified in this study included teachers providing answers or asking closed questions. Nonetheless, in this study, these were not the types of oral interactions that students perceived helped their learning, whereas this study has identified tangible ways in which teachers might change their practice to better support what students think helps them learn.

The findings from this study indicated that *how* the teachers engaged the students in the feedback process was important, as well as the types of oral feedback that they used, and teachers were observed using the oral feedback types identified in the study in differing ways with their students. From the analysis conducted in this study it was possible to identify differences in classroom feedback practices amongst the teachers that were linked to both divergent and convergent ideal-typical approaches (Torrance & Pryor, 2001, see Table 2.2). Within divergent interactions, students were supported to behave as *dynamic* co-agents in the feedback process, with teachers drawing on constructivist pedagogical practices. On the contrary, during convergent interactions, students were treated as *passive* recipients in the feedback process, with teachers utilising behaviourist pedagogical practices.

As a result of the cross-sectional analysis of all findings generated from the data, this study contributes to our understanding of oral feedback, by contributing a theoretical framework, with practical and theorised implications of both ideal typical approaches to feedback, developed from the work of Torrance and Pryor (2001). Torrance and Pryor's framework focused on ideal typical approaches to assessment, and this study has extended their framework by applying it to the findings related to teachers' oral interactions within science classrooms. Analogous with Torrance and Pryor's (2001) classroom assessment model, teachers' feedback repertoires drew on multiple practices aligned to differing learning assumptions, indicating the feedback ideal typical approaches are not "necessarily mutually exclusive in practice" (Torrance & Pryor, 2001, p. 616). This theoretical framework

with divergent and convergent ideal typical approaches to oral feedback can be seen in Table 7.1.

Convergent	Divergent

Feedback undertaken between teacher and student as a uni-directional process with students operating as *passive* recipients of information on which they subsequently act. This is characterised by:
 	
Practical Implications
• Teachers utilising fewer of the oral feedback types and more:
  ○ Directive teaching approaches.
  ○ Closed questioning.
• Teachers more likely to:
  ○ Provide answers or ideas for next steps;
  ○ Conduct a greater number of whole class interactions with students;
  ○ Employ triadic dialogue teaching practices;
• Students being dependent on the teacher
 	
Theoretical Implications
• A behaviourist view of feedback focused on providing judgements in terms of facts memorised, concepts acquired or content mastered;
• An intention to move forward learning to the next predetermined thing in a linear progression.
• A view of feedback as a gift accomplished mainly by the teacher, with the locus of responsibility and cognition with the teacher.
 	
This view of feedback attends more closely to traditional theories of learning and learning in science.
	Feedback undertaken between teacher and student as a two-way bi-directional process with students operating as *dynamic* co-agents generating evaluative knowledge and identifying how they should subsequently act. This is characterised by:
	
	Practical Implications
	• Teachers utilising more of the oral feedback types (*discrepancy,* success criteria interactions and open questions) and more:
	  ○ Promotion of student-directed learning.
	• Teachers more likely to:
	  ○ Be less directive;
	  ○ Conduct a greater number of small group or individual interactions with students;
	  ○ Employ dialogic teaching practices;
	• Students more likely to work independently
	
	Theoretical Implications
	• A social constructivist view of feedback focused on the quality of a student's learning or degree of expertise;
	• An intention to develop learning in the zone of proximal development;
	• A view of feedback as loops accomplished jointly by the teacher and student, with the locus of responsibility and cognition shifting to the student.
	
	This view of feedback attends more closely to progressive theories of learning and learning in science.

Table 7.1 Theoretical ideal typical feedback framework generated by study

Finally, in light of the findings ascertained from the analysis across teachers' and students' perceptions and teachers' classroom practices, the initial conceptualisation of feedback presented was updated to make explicit the more distributed model of learning highlighted in the literature as benefitting students (Askew & Lodge, 2000; Buhagiar, 2005; Gipps et al., 2000; Hargreaves, 2012, 2013, 2014, 2016; Nuthall, 2007; Torrance & Pryor; 2001; Tunstall & Gipps, 1996; Voerman et al., 2014; Watkins et al., 2002, 2007). As such, a broadened out

definition aligned to divergent approaches affiliated with effective learning conceptualises feedback as:

Useful information generated with an agent (teacher, peer, book, parent, self or personal experience, including practical work) which supports learning, relates to learning goals, regarding aspects of one's performance or understanding, and is utilised to improve one's learning of science.

Findings from the analysis of teachers' conceptions, students' perceptions and the analysis of teachers' classroom practices afford insights as to how teachers and students can maximise learning opportunities in science classrooms. Improved oral feedback practices have the potential to benefit students in terms of encouraging *dynamic* behaviours, which in turn can improve outcomes in terms of performance, not only in science lessons, but more importantly for individuals as life-long learners and members of society. Consequently, findings from the study have the potential to inform policy makers and CPD facilitators as to how best to support teachers in adopting and implementing effective feedback practices, especially those associated with oral feedback. Potential implications of the study will be explored in the next section.

7.3 Implications of Study

The findings of this study suggest that there may be particular types of oral interactions and divergent practices that occur during *dynamic* interactions between teachers and their students that are beneficial in helping learners develop understanding in science. The findings of this research provide insights for teachers of practical approaches to oral feedback they can implement to help students' learning. These include:

- More 'visible' discussions throughout lessons related to the learning goals, including what quality and success look like in comparison to them;
- The increased use of all oral feedback types (*discrepancy* feedback; success criteria interactions; open questions) during oral interactions;
- Fewer oral interactions spent engaging in directive teaching and closed questioning with students;

- Encouraging *dynamic* students behaviours so that students are enabled to be cognitively engaged, active and involved in generating evaluative knowledge to identify how they should subsequently act;
- Promoting student-directed learning, especially by not providing answers, so students are provoked to work on their own or with peers;
- Employing more sociocultural learning opportunities including dialogic teaching practices;
- Highlighting *discrepancy* learning opportunities to all students;
- Facilitating more sociocultural and cognitive learning opportunities, in which students work with peers or independently;

Not only do the findings indicate possible aspects of classroom practices that are beneficial, the study appears to support the argument for a change in the way that some teachers work with their students. This change would mean feedback becomes a two-way bi-directional exchange of information as a "*dynamic* generative process" (Plank et al., 2014, p.107) with teachers and students learning from each other and action required from both parties (Dann, 2018; Vercauteren, 2009). This divergent approach to feedback, and consequently teaching and learning, takes a considerable amount of skill and an appropriate attitude and particular tenets on behalf of the teacher. Indeed, even if teachers have all of the required knowledge and skills about feedback, without the appropriate attitudes towards the role that it can play in teaching and learning, their knowledge and skills will lie dormant (Heritage, 2007).

The findings will be of interest to policy makers, practitioners, researchers and those involved in providing professional support for educators. Nevertheless, even though it is easier for policy makers and CPD facilitators to focus on developing the practical aspects of classroom practice, since they provide quick and tangible ways to develop teaching, such gains are superficial and "a great deal of prior research shows how teachers can bend or distort new materials to fit their existing conceptions… new materials by themselves have proved a relatively weak instrument for changing pedagogy" (Thompson & Zeuli, 1999, p. 351). Therefore, in order to ascertain deeper levels of professional learning, what is of more importance is supporting teachers in shifting their beliefs (Niederhauser & Stoddart, 2001). Deeper levels of learning would require engaging teachers with constructivist

learning theories and divergent approaches to feedback, as this is more likely to develop teachers' attitudes and consequently impact on student learning. However, constructivist and divergent approaches to feedback necessitate teachers relinquishing the dominant stance within the classroom, in order to reflect on and evaluate their learning. This would entail shifting the locus of responsibility, and consequently allowing students to actively construct meaning, collaborate and take responsibility for their learning through increased learner autonomy, and are practices which in the current educational climate may be difficult for some teachers to embrace (Knight, 2003; Sadler, 1989). Notwithstanding, such approaches have the potential to optimise learning opportunities and develop appropriate behaviours for students, to ensure that as a result of their engagement in education they are provided with a passport to lifelong learning (UNESCO, 1996).

Therefore, to be effective in shifting teachers' beliefs, CPD must provide practitioners opportunities to reflect on practice, engage in dialogue, be based in actual work with students, and provide opportunities for peer observation, coaching and feedback (Joyce & Showers, 1980; Robinson and Sebba, 2004). Requirements of such transformative CPD experiences are that it provides:

1. Cognitive dissonance to disturb teachers' existing ideas about content, pedagogy, and learning;
2. Time, contexts and support for teachers to think through the conflicts to new ideas;
3. Opportunities for the teachers to connect new ideas to their own students and contexts;
4. Support in developing a repertoire of strategies and techniques to draw on in the on-going flow of practice;
5. Support for the continuing reconstruction over an extended period (Thompson and Zeuili).

One way that this can be facilitated is through engaging teachers in collaborative action research projects with like-minded peers (Harrison, 2013). This approach can support teachers in making sense of and develop their classroom practices. Factors identified as supporting this development of practice involve teachers not only believing in the approaches that they are undertaking but also, by

engaging in collaborative action research, creating a sense of ownership of the change process (Harrison, 2013).

It is therefore recommended that policy makers and CPD facilitators wishing to develop teachers' oral feedback practices create professional learning communities engaged in action research. Such learning communities could: model and exemplify the different types of oral feedback identified within this study (*discrepancy* and success criteria interactions, open questions), consider divergent and convergent approaches along with *passive and dynamic* behaviours engendered when implementing them; employ the analytical framework created by this study to reflect on each others' practice; engage in dialogue around divergent and convergent teaching approaches and the underlying learning theories; interview their students using the research methods utilised in this study; analyse students' responses and compare them with the findings from this study to identify congruity or discrepancies; and peer observe and coach each other with regards to divergent approaches, in particular the different types of oral feedback interactions utilised and how they promote student-directed learning and nurture *dynamic* feedback interactions. Collectively and over time, with the appropriate support and access to stimulus materials, teachers could critically reflect upon, and evaluate their practice, in order to develop these evidenced-based professional learning communities that change pedagogy and impact on student learning.

If the tentative findings of the study are corroborated, then this could lead to a rethinking of the most effective balance between written and oral feedback and how this might impinge on teachers' practice. There is, then, the potential for this shift to reduce issues associated with teachers' current workload levels associated with the increased levels of accountability rife across the current education landscape (Department for Education, 2016a; 2016b; 2016c).

7.4 Further Areas of Research

This study grew out of a concern regarding the lack of evidence about what feedback looks like in authentic settings, namely secondary science classrooms. The findings contribute to our understanding of science teaching and learning in several ways. This research has thrown up many questions in need of further investigation.

As a result of the findings in this study, some oral feedback types have been indicated as being potentially beneficial. One aspect of oral interactions that is noteworthy is the students' lack of perceived benefit in terms of helping learning,

attributed to *progress* information, which has been found previously to constitute feedback. *Progress* information is consistent with the literature derived definition of feedback, however, students' lack of reference to this oral interaction might be due to the infrequent use of such interactions in the lessons observed in this study. For students to be able to identify what the teachers has said to help them learn, the teacher must actually say it. The lack of reference to *progress* information is an intriguing one, which could be usefully explored, in further research.

A natural progression of this work is to analyse oral feedback interactions in science in a range of other educational establishments; not just those judged by Ofsted as outstanding, to see if any of the findings identified in this study are relatable.

If the debate is to be moved forward, a better understanding of how students respond to oral feedback and how this improves their learning also needs to be developed. Future research could therefore usefully explore any quantifiable impact that the different types of oral feedback have on students' learning.

Further research might explore the role of oral feedback during student-to-student interactions or indeed when students work on their own. This research could usefully examine whether any aspects related to oral feedback identified by the findings from this study, are relevant to these peer-to-peer or individual 'communications', and support students' learning in authentic classroom settings.

7.5 Autobiographical Reflections

As a professional who has engaged for many years with research in order to harness ideas from it, and translate them into meaningful CPD experiences for teachers with strategies that they can take away and employ in the classroom, I now have first-hand experience of how valuable enquiries can be. I felt that the time had come to be part of the community that planned for and carried out - rather than used - the findings of an investigation. To that end the biggest learning journey for me has been discovering the process of research. I feel that I remain a research apprentice and still have more to learn about the process. I have found that the work of a researcher can be lonely, hard work and that resilience and an open mind are vital, and yet at the same time it has been immensely rewarding and thought provoking.

The research study has not only provided me with a greater insight and key ideas about feedback, it has made me re-examine practices and approaches that I undertake across different aspects of my professional life. I intend to continue

exploring aspects of feedback and learning to support and challenge teachers through CPD experiences. Indeed, since completing the data collection and analysis of this research, I have returned to both schools and facilitated CPD sessions on feedback for all of the science teachers within their departments. Personally, I now feel that I have more credibility as a CPD facilitator running the sessions as a consequence of having operated as a researcher in the field.

7.6 Chapter Summary

The findings of this study have a number of important implications for future practice. This study has enhanced understanding of oral feedback in secondary science classrooms. Oral interactions that are perceived by students as being beneficial to their learning require them to engage in feedback with their teachers, in which the language of learning is at the heart of the dialogue. This emphasis on dialogue associated with learning goals, the quality of learning and how to develop learning in many lessons will require a shift from the sharing of learning intentions at the start of a lesson, to a sustained and visible communication of learning involved in all aspects of classroom work, in which thinking is 'opened up' and made public to all. Alongside this highly 'visible' communication of learning, there needs to be a shift in the locus of responsibility for the learning from the teacher to the student, with *dynamic* relationships being built instead of *passive* ones, in order that students are made to think, rather than receive directives as a consequence of the teacher having done the thinking on their behalf. Therefore, if feedback is to be considered effective for students, they must be supported to think for themselves before they truly know and understand, and teaching must provide for them those linguistic opportunities and encounters which will enable them to do so (Alexander, 2014; Black et al., 2002). These insights support previous research carried out in non-science contexts, and suggest practical ways in which teachers and students can maximise the benefits of the feedback process to support learning within the classroom.

If such approaches are to be undertaken and embedded in classrooms, then teachers need to be released from the high levels of accountability associated with evidencing work in books and producing copious amounts of data, practices which have become prevalent in many schools as a consequence of the pressures of inspections and performance measures under which many teachers find themselves labouring. With time, support and effort to develop the teacher-student relationship, and understand the importance of learning and the language employed during feedback, educators, policy makers and CPD facilitators can find ways to expand

teachers' practices and consequently develop the behaviours of learners to become owners of their own learning. Such changes have the lifelong potential of benefiting both the individual and the wider society within which they reside and contribute.

Appendices

Appendix 1 - Summary of research findings associated with feedback studies

Study	Feedback Type (written/ oral/ both)	Focus	Participant Details	Context Details (phase/subject/ classroom based etc.)	Relevant findings	Points of Note for This Study
Weeden and Winter (1999)	Both	Students' perspectives	200 students from twenty schools	England, primary and secondary (Year 3 to Year 13), group and individual student interviews	• Feedback valued particularly oral • Much feedback either unfocused or of little use in improving work. • Wide range of forms of feedback, some not understood. • Discrepancy comments welcomed by all students.	• Not subject specific • No teacher perceptions reported • No lesson observations conducted • No clear definition of feedback provided
Gipps et al. (2000)	Generic not linked to oral or written	Teachers' practices & perspectives & students' perspectives	Twenty four teachers involved, numbers of students not specified	England, primary English, maths & science lessons (Year 6) and English and maths lessons (Year 2) and teacher and student interviews.	• Teachers see feedback as helpful to learning through: praise; *discrepancy*; *progress*; success criteria interactions. • Teachers use evaluative & descriptive types of feedback. • Teachers' feedback strategies shift from directive telling to passive students towards supportive, proactive participation, engagement and initiation with students.	• Teachers' perceived written feedback helps learning, teachers of younger students emphasised benefits of immediate oral feedback. • Primary phase, • Science observed, • Questioning used to promote thinking, feedback cited associated with science inquiry work.
Knight (2003) An evaluation of the quality of teacher feedback to students.	Both	Teachers' practices	Six teachers involved	New Zealand, primary numeracy lessons observed (Years zero to 6 students) and teacher interviews.	• Teachers unclear about what constitutes feedback. • Instruction confused with feedback, questioning is a form of instruction rather than feedback. • Prevalence of positive evaluative feedback (praise)	• No student perspectives gathered • Primary phase; • Numeracy focus • No explicit findings linked to specific aspects of oral feedback
Chin (2006) Classroom interaction in science.	Oral	Teachers' practices	Two teachers involved	Singapore, secondary science lessons (Year 7 students) audio and video recordings	• Teachers' use of open questioning can increase student thinking. • IRF evaluative exchanges were pervasive.	• No teacher or student perspectives gathered • Not all oral interactions in a lesson recorded and analysed, therefore limiting trustworthiness of findings

Study	Feedback Type (written/ oral/ both)	Focus	Participant Details	Context Details (phase/subject/ classroom based etc.)	Relevant findings	Points of Note for This Study
Peterson and Irving (2008) Secondary school students' conceptions of assessment and feedback	Generic discussions about feedback linked to tests	Students' perspectives	Student focus groups	New Zealand, secondary maths and English students group interviews (Year 9 or 10 students)	• Students see assessment and feedback as inextricably linked • Feedback seen as providing ideas of what and how to improve	• No teachers' perspectives • English and maths • Feedback discussions only associated with tests and no explicit findings linked to specific aspects of oral feedback • No classroom observations
Vercauteren (2009) Do they get the picture? Feedback in primary classrooms	Generic discussions about feedback	Teachers' and students' perspectives	Four teachers and sixteen students	New Zealand, primary, individual student interviews (7 to 10 year olds), teachers interviewed afterwards	• Evaluative feedback prevalent • Students not always aware of success criteria relating to their work • Students found *discrepancy* and *progress* feedback most helpful	• No classroom observations • Primary phase • No subject focus • No explicit findings linked to specific aspects of oral feedback
Williams (2010) You know what you've done right and what you've done wrong and what you need to improve on	Generic not linked to oral or written	Students' perspectives	Student focus groups	New Zealand, secondary students completed questionnaire and follow up group interviews (Year 8 students)	• Students showed some preference for oral feedback • *Discrepancy* and *progress* feedback was considered most helpful by students • Students able to comment on their own learning	• No teachers' perspectives • No subject focus • Feedback types presented to students therefore potential to limit findings. • No classroom observations • No explicit findings linked to specific aspects of oral feedback

Study	Feedback Type (written/ oral/ both)	Focus	Participant Details	Context Details (phase/subject/ classroom based etc.)	• Relevant findings	• Points of Note for This Study
Hargreaves (2011) Teachers' feedback to pupils: "Like so many bottles thrown out to sea"?	Generic not linked to oral or written	Teachers' and students' perspectives	Eighty eight teachers, seven student interviews	UK, Chile, Greece & USA teachers surveyed. Primary students (9 to 10 year olds).	• Feedback becomes effective when: ○ Social and personal factors are supportive to focus on learning; ○ Focus is appropriate; ○ Form of message is accessible to learner	• No teacher interviews, or classroom observations • Primary phase, not subject specific • Students' perceptions not drawn on in detail. • No explicit findings linked to oral feedback
Voerman et al. (2012) Types and frequencies of feedback interventions in classroom interaction	Oral	Teachers' practices	Seventy six teachers lessons recorded	Holland, secondary teachers across all age ranges, lessons analysed.	• Feedback interactions occurred rarely with few specific to learning and more as *discrepancy* than *progress* • Different views amongst the researchers as to whether questions could be classed as feedback	• Only one 10 minute section of each teacher's lesson analysed • Observation framework used required researchers to stop and consult, calls into question the efficacy of instrument, and trustworthiness of findings • No teachers' or students' perspectives • Range of subjects, including science
Hargreaves (2012, 2013, 2014) Inquiring into children's experiences of teacher feedback	Generic not linked to oral or written	Students' perspectives	Nine profile students	UK, primary students, observed in lessons and post-lesson interviews (Year 5 students)	• Divergent feedback practices focused on students' inquiries can enable them to take responsibility for their learning • AfL as a learning conversation between teacher and students can improve autonomous learning	• No teachers' perspectives • Primary phase • Literacy and numeracy lessons • No explicit findings linked to specific aspects of written feedback or oral feedback

Study	Feedback Type (written/ oral/ both)	Focus	Participant Details	Context Details (phase/subject/ classroom based etc.)	Relevant findings	Points of Note for This Study
Ruiz-Primo and Li (2013) Analysing teachers' feedback practices in response to students' work	Written	Analysis of marking in students notebooks	N/A	USA, elementary and middle school science students work analysed	• The majority of teachers provided students with written feedback in some form • Frequency varied across teachers and grades • Majority of comments were evaluative, with 5% of comments being incorrect	• No teachers' or students' perspectives • No perceived benefits of learning ascertained • No classroom observations • No explicit findings linked to specific aspects of oral feedback • Science work was subject focus
Gamlem and Smith (2013) Student perceptions of classroom feedback	Oral	Students' perspectives	Eleven student interviews	Norway, secondary, lesson observations and post-lesson interviews (13 to 15 year olds)	• Students who find feedback useful value and use it • Peers can provide support and feedback to each other and this can be preferred to teacher feedback	• No teachers' perspectives • Not subject specific • No perceived benefits of learning ascertained
Plank, Dixon and Ward (2014) Student voices about the role feedback plays	Oral	Students' perspectives	Student focus groups	New Zealand, secondary students, interviews (Year 13 students)	• Beneficial feedback was construed as teacher and peer dialogue around learning with both having parts to play	• No teachers' perspectives • Not subject specific • No classroom observations • No explicit findings linked to specific aspects of oral feedback interactions
Gamlem and Munthe (2014) Mapping the quality of feedback to support students' learning	Oral	Teachers' practices	Twenty eight teachers video-recorded	Norway, secondary school, 56 lesson recordings from across 19 different classes and subjects including science analysed (13 to 16 year olds)	• Feedback more encouraging than learning orientated • Lessons characterised by a positive climate, with social and affective dialogue prevalent	• No teachers' or students' perspectives • Data collected across large number of different secondary subjects, no science specific points • No explicit findings linked to specific aspects of oral feedback interactions

Study	Feedback Type (written/ oral/ both)	Focus	Participant Details	Context Details (phase/subject/ classroom based etc.)	Relevant findings	Points of Note for This Study
Murtagh (2014) The motivational paradox of feedback	Both	Teachers' practices & perspectives & students' perspectives	Two teachers, 12 students	UK, primary, teachers observed and interviewed and student focus group interviews (Year 6, 10 to 11 year olds)	• Evaluative and phatic feedback prevalent, especially with written • Students prefer descriptive feedback • Locus of responsibility with teacher	• Primary phase • Not subject specific
Dann (2015a) Developing the foundations for dialogic feedback	Written	Students' perspectives	Ten students	UK, primary literacy and numeracy focus, one to one interviews (Year 5, 9 to 10 year olds)	• Dialogue around learning would benefit students as they perceived next steps linked to tasks and not learning • *Discrepancy* feedback in literacy better understood than in numeracy	• No teachers' perspectives • No classroom observations • Primary phase • Not subject specific • Interviews drew on real and imagined contexts
Nadeem (2015) Streamlining verbal feedback	Oral	Researcher's and students' perspective	Researcher and student interviews	Pakistan, secondary lesson recordings and students interviewed by researcher (Year 9 and 11 students)	• Verbal feedback can be made more effective if reduced to key points only	• No subject specified • Teacher as researcher and no indications of approaches undertaken to mitigate for bias, or trustworthiness of findings.

Appendix 2 - Studies analysing teachers' classroom feedback practices

Author/s and Title of Study	Study Details	Total Number of Hours	Age of Students	Additional Information on Methodology and Methods
• Knight (2003) An evaluation of the quality of teacher feedback to students: A study of numeracy teaching in the primary education sector	2 Schools 6 Teachers 3 Lessons per teacher	18	5-11 year olds	Methodology: Not stated. Interviews with the teachers, observations of numeracy lessons, follow-up discussions with teachers after the lessons and document analysis. Verbatim transcripts taken of the dialogue between the teacher and students and analysed. No student interviews or mention of how transcripts produced from dialogue; not sure if written or recorded.
• Chin (2006) Classroom Interaction in Science: Teacher questioning and feedback to students' responses	2 Schools 2 Teachers 7 Lessons per teacher	14	11-12 year olds	Methodology: Not stated. Most of the talk recorded was during direct instruction of whole class with limited small group recordings. Only audio during whole class settings and some small groups recorded. Video recordings use to make interpretive notes. Audio transcripts analysed. No teacher or student interviews.
• Voerman et al. (2012) Types and frequencies of feedback interventions in classroom interaction	8 Schools 78 Teachers 1 lesson	10 minutes of a lesson/ teacher	Secondary students in Holland	Methodology: Not stated. Data collected from one lesson per teacher, length of lessons varied from 45-70 min. One fragment of ten contiguous minutes of interaction between teacher and individual/ small group of students analysed using: videos; observation instrument developed in pilot study. No student interviews or mention of transcripts produced.
Key of methods identified: Interviews; Lesson observations and/or field notes; Video or audio recordings; Transcripts produced; Analytical frameworks; Other forms of data such as: end of unit tests, photos of students work				

Author/s and Title of Study	Study Details	Total Number of Hours	Age of Students	Additional Information on Methodology and Methods
• Murtagh (2014) The motivational paradox of feedback	2 School 2 Teachers 12 Lessons	24	10-11 years old	Methodology: Case study of two teachers Data collected within literacy lessons as both teachers were literacy coordinators using: observations and field notes; samples of pupils' work; teacher and student semi-structured interviews. No mention of transcripts.
• Gamlem and Munthe (2014) Mapping the quality of feedback to support students' learning in lower secondary schools	4 Schools 28 Teachers 2 Lessons per teacher	56	13-16 years old	Methodology: Experimental design Pre-designed and validated observation manual employed to conduct content analysis of video recordings of lessons. No interviews with either teachers or students.
Key of methods identified: Interviews; Lesson observations and/or field notes; Video or audio recordings; Transcripts produced; Analytical frameworks; Other forms of data such as: end of unit tests, photos of students work				

Appendix 3 - Studies analysing students' perspectives of classroom feedback

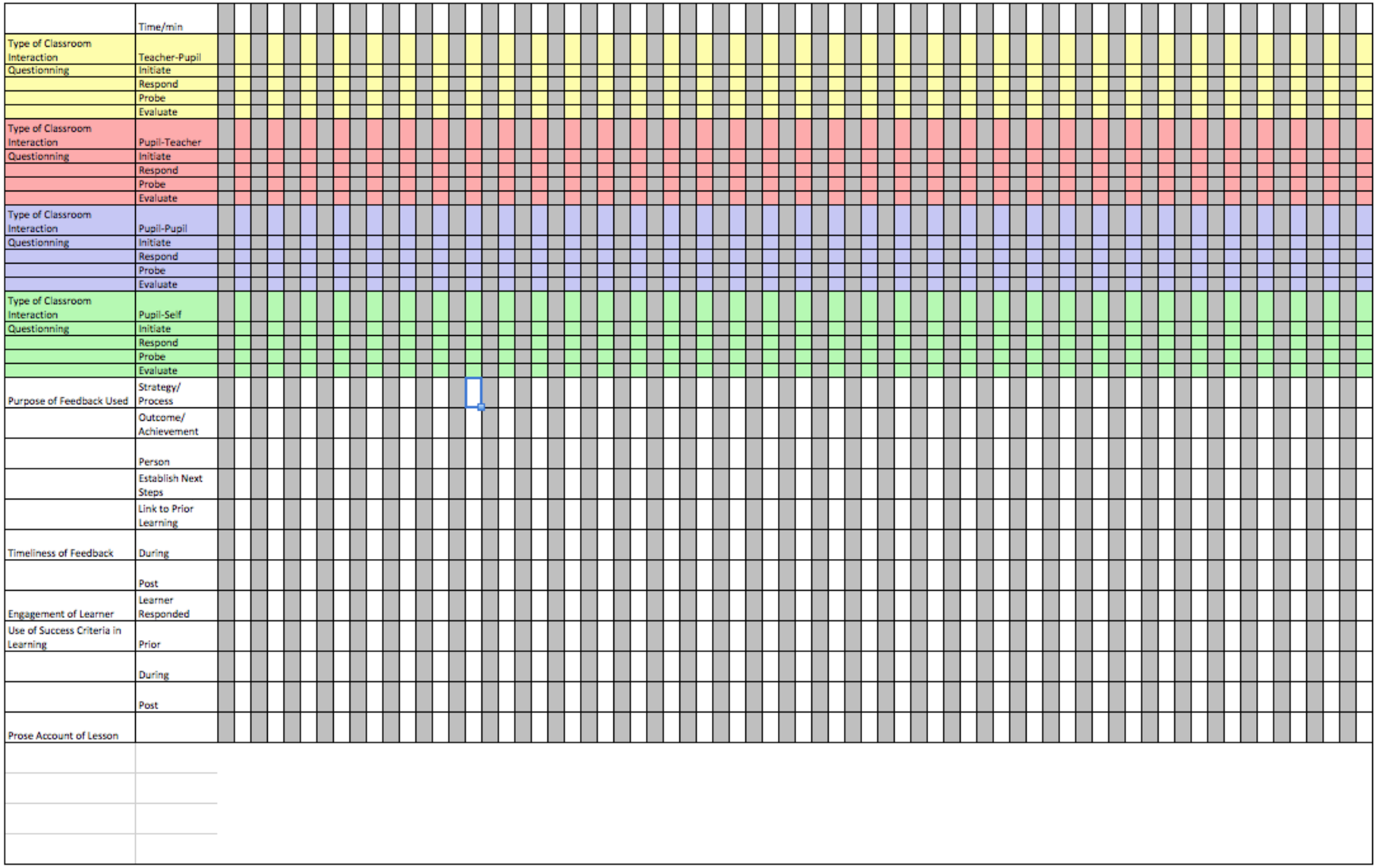
Author/s and Title of Study	Study Details	Number of Interviews	Age of Students	Additional Info on Methodology and Methods
• Carnell (2000) Dialogue, discussion and feedback – views of secondary school students on how others help their learning	1 School 14 Students interviewed from 5 classes	Number not stated, focus groups of twos or threes	11-16 years old	Methodology: Focus groups. Students interviewed in twos or threes semi-structured interviews. Analysis of interview transcripts. No teacher interviews or in lesson observations, no mention of interview recording approaches used.
• Peterson and Irving (2008) Secondary school students' conceptions of assessment and feedback.	4 Schools 41 Students interviewed from maths and English classes	5 focus groups 6-10 students per group	New Zealand Y9 & Y10	Methodology: Focus groups Semi-structured interviews of student focus groups and recorded during school time and transcripts produced and analysed. No teacher interviews or in lesson observations.
• Vercauteren (2009) Do they get the picture? Feedback in primary classrooms	2 Schools 16 Students from 4 classes	1 per student	7-10 year olds	Methodology: Not stated Students interviewed individually for 30-40 mins. Interviews audio recorded and transcribed. No subject focus, teachers also interviewed, no lesson observations.
Key of methods identified: Interviews; Lesson observations and/or field notes; Video or audio recordings; Transcripts produced; Analytical frameworks; Other forms of data such as: end of unit tests, photos of students work				

Author/s and Title of Study	Study Details	Number of Interviews	Age of Students	Additional Info on Methodology and Methods
• Williams (2010) You know what you've done right and what you've done wrong and what you need to improve on'	2 Schools 56 Students from 2 classes	Number not stated, students in groups	12-13 year olds	Methodology: Focus groups Questionnaire given to 56 students with predetermined types of feedback. Followed up semi-structured interviews of 8 identified students in focus groups. Interviews transcribed. No subject focus, no teacher interviews or in lesson observations, no mention of recording interviews.
• Hargreaves (2012, 2013, 2014) Inquiring into children's experiences of teacher feedback	1 School 9 Students from 1 class	Number not given; group, paired or individual	9-10 year olds	Methodology: Longitudinal study Lesson observations and video recordings made over a 6 month period. Recordings of lessons show to students during semi-structured interviews. Interviews analysed. No teacher interviews or mention of transcripts made.
• Gamlem and Smith (2013) Student perceptions of classroom feedback.	4 Schools 11 Students in total from 6 classes	1 per student	13 – 15 years old	Methodology not clear. 2 lesson observations video recorded of each class some time before the interviews to develop interview guide; video recording of semi-structured student interviews; transcripts produced. No teacher interviews.
Key of methods identified: Interviews; Lesson observations and/or field notes; Video or audio recordings; Transcripts produced; Analytical frameworks; Other forms of data such as: end of unit tests, photos of students work				

Author/s and Title of Study	Study Details	Number of Interviews	Age of Students	Additional Info on Methodology and Methods See Section 4.3.1 for colour key
• Plank, Dixon and Ward (2014) Student Voices about the Role Feedback plays in the Enhancement of their Learning	1 School 14 Students in total from a number of Y13 classes	2 focus groups 6 students in one 8 students in other	New Zealand Y13	Methodology: Focus Groups Semi-structured student interviews using an interview schedule; interview transcripts used. No lesson observations or interviews with teachers or information on how interviews recorded.
• Nadeem (2015) Streamlining verbal feedback	1 School 18 students from 2 classes.	2 focus groups: 6 students in one 12 students in other	Pakistan, Secondary Year 9 and 11 students	Methodology: Action research Video recorded classroom activities, recorded and analysed students' interviews. Compared students' work before and after feedback. Researcher was teacher of first class and not of second.
Key of methods identified: Interviews; Lesson observations and/or field notes; Video or audio recordings; Transcripts produced; Analytical frameworks; Other forms of data such as: end of unit tests, photos of students work				

Appendix 4

Observation Schedule
Class: No of Pupils:
Date Time:



Appendix 5

Teacher Initial Collection Interview Schedule

For teachers:

1. What is your understanding about feedback?
2. How would you describe your normal feedback practices?
3. How often do you provide oral feedback to your students?
4. What are your intentions, what are you hoping to achieve when you provide oral feedback?
5. What challenges do you face in terms of providing oral feedback to your students?
6. How do you try and overcome these challenges?
7. What characteristics of oral feedback do you believe help improving the students' learning?
8. How confident do you feel in giving and acting upon oral feedback in the classroom?

Appendix 6

Teacher Final Collection Interview Schedule

For teachers:

General Questions

1. How long have you been teaching?
2. How many different schools have you worked in?
3. What is your current role and do you have any responsibilities in school?
4. Which CPD experiences have had a significant impact on your thinking and practice? What were they and was has been their impact?
5. What CPD have you undertaken in AfL? What were they and what has been their impact?
6. What else influences your assessment practice?

Appendix 7

Student Interview Schedule

For students:

1. What do you think the teacher wanted you to learn today?
2. Why do you think you need to learn this?
3. What did you learn today?
4. How do you know that you have learnt it?
5. What helped you learn in the lesson today?
6. Was there anything the teacher said that helped you learn? If yes what was it and how did it help?

Appendix 8 - Origins of Analytical Framework Oral Interaction Types

Origins of Type	Type of Oral Interaction
Teacher and student interviews	***Discrepancy* Information**
Teacher and student interviews	***Progress* Information**
Teacher and student interviews	**Promotion of Student-Directed Learning**
Teacher and student interviews	**Open Questions**
Lesson Observations	**Closed Questions**
Student interviews	**Success Criteria**
Lesson observations	**Directive Teaching**
Lesson observations	**Praise/Punishment**
Lesson observations	**Summarising**
Lesson Observations	**Encouraging Student Engagement**

Appendix 9 Lesson Recording Analytical Framework Teacher _____ Lesson _____ Date _____

Oral Interaction Types	Tally – Whole Class Interactions	Tally – Small Group Interactions	Notes
Teacher provides ***discrepancy*** information i.e. how to improve in relation to goal, identifies errors and/or misunderstandings to correct			
Teacher provides ***progress*** information i.e. information about what has been done well in relation to goal			
Teacher **promotes student-directed learning** i.e. provokes students to generate own solutions on own or with peers			
Open questions			
Closed questions			
Teacher provides information about **success criteria** (quality/standards) related to goal			
Teacher provides **answer/direct teaching** of the science			
Teacher provides **information/instructions about task/s**			
Teacher provides generic **praise/punishment**			
Teacher **summarises** points made or earlier learning			
Teacher **encourages** students to participate in lesson			

Appendix 10

THE UNIVERSITY of York

Department of Educational Studies

Ethical Issues Implementation Form

This form is intended to check that decisions taken when planning your research study have been implemented as intended.

Please give the completed form to the Higher Degrees Administrator.

Surname / family name:	
First name / given name	
Programme:	
Supervisor (of this research study):	
Topic (or area) of the proposed research study:	

As your research study proceeds, please enter dates by which each of the items in this table has been completed. If any of these actions does not apply to your study, enter NA (not applicable) in the right-hand column.

	Action	**Date**
1	Signed *informed consent* forms received from all participants (and all others whose consent is needed)	
2	Check made that questions asked of research subjects are unlikely to cause distress	
3	Arrangements made to ensure another adult is present during interviews (or other forms of data collection) with subjects under age 16	
4	Discussion with all relevant individuals/groups of the nature of any intervention involved in the research study, and agreement to proceed	
5	Records of interviews, discussions, observations sent to participants for checking and comment	
6	Primary data appropriately anonymised during the analysis process	
7	Report of research checked to ensure that individual research subjects, or their schools/institutions cannot be identified	

Signed:

Date:

Appendix 11

THE UNIVERSITY of York

Department of Educational Studies

Ethical Issues Audit Form

This questionnaire should be completed for each research study that you carry out as part of your degree. You should discuss it fully with your supervisor, who should also sign the completed form

Surname / family name:	
First name / given name	
Programme:	
Supervisor (of this research study):	
Topic (or area) of the proposed research study:	
Where the research will be conducted:	
Methods that will be used to collect data:	

Data sources

1 Does your research involve collecting data from people, e.g. by observing them, or from interviews or questionnaires. YES/NO

Note: The answer to this will normally be 'yes'. It would only be 'no', if the research was entirely based on documentary sources, or secondary data (already collected by someone else). If the answer is 'no', then please go straight to question 12.

Impact of research on the research subjects

For studies involving interviews, focus group discussions or questionnaires:

2 Is the amount of time you are asking research subjects to give reasonable? Is any disruption to their normal routines at an acceptable level? YES/NO

3 Are any of the questions to be asked, or areas to be probed, likely to cause anxiety or distress to research subjects? YES/NO

4 If the research subjects are under 16 years of age, have you taken steps to ensure that another adult is present during all interviews and focus group discussions, and that questions to be asked are appropriate? YES/NO

<u>For studies involving an intervention (i.e. a change to normal practices made for the purposes of the research):</u>

5 Is the extent of the change within the range of changes that teachers would normally be able to make within their own discretion? YES/NO

6 Will the change be fully discussed with those directly involved (teachers, senior school managers, students, parents – as appropriate)? YES/NO

Informed consent

7 Will steps be taken to inform research subjects in advance about what their participation in the research will involve? YES/NO

8 Will steps be taken to inform research subjects of the purpose of the research? YES/NO

Note: For some research studies, the data might be seriously distorted by informing research subjects in advance of the purpose of the study. If this is the case (and your answer to question 8 is therefore 'no'), please explain briefly why.

---

9 Will steps be taken to inform research subjects of what will happen to the data they provide (how this will be stored, for how long, who will have access to it, how individuals' identities will be protected during this process)? YES/NO

10 In the case of studies involving interviews or focus groups, will steps be taken to allow research subjects to see and comment on your written record of the event? YES/NO

11 Who will be asked to sign a statement indicating their willingness to participate in this research? Please **tick all categories** that apply:

Category	***Tick if 'yes'***
Adult research subjects	
Research subjects under 16	
Teachers	
Parents	
Headteacher (or equivalent)	
Other (please explain)	

Reporting your research

12 In any reports that you write about your research, will you ensure that the identity of any individual research subject, or the institution which they attend or work for, cannot be deduced by a reader? YES/NO

If the answer to this is 'no', please explain why:

Signed:

Date:

Please now give this form to your supervisor to complete the section below.

NOTE:

If your plans change as you carry out the research study, you should discuss any changes you make with your supervisor. If the changes are significant, your supervisor may advise you to complete a new 'Ethical issues audit' form.

To be completed by the supervisor of the research study:

Please ☑ one of the following options.

	I believe that this study, as planned, meets normal ethical guidelines
	I am unsure if this study, as planned, meets normal ethical guidelines
	I believe that this study, as planned, does not meet normal ethical guidelines and requires some modification.

Signed:

Date:

Appendix 12

Parent/Carer Study Information Sheet

'Oral teacher feedback in science classrooms'

Dear Sir/Madam,

My name is Andrea Mapplebeck and I am currently carrying out a research project to identify the types of dialogue that occur in science classrooms and how they help students to learn. I am writing to ask if your child is able to take part in the study.

What would this mean for my child?

The study will involve me as the researcher:

Observing a sequence of science lessons from each of the teachers involved in the study.

Recording the science lessons with audio and possibly video equipment.

Photographing lesson plans and students' work.

Audio recording interviews with focus groups of students.

Audio recording interviews with the science teachers.

The interviews will take place during the normal school day at a time and in a place convenient to the participants in order that they do not cause disruption to their teaching schedule. The interviews will last a maximum of 30 minutes.

Anonymity

The data gathered (e.g. audio/video recordings of the lessons, audio recordings of the interviews, notes from observations, photos) will be stored by code number only known to me as the researcher. Any information that identifies your child/ their school or teachers will be stored separately from the data. The video footage will only be used during the data analysis and will not be shared with anyone.

Storing and using your data

Data will be stored securely and will be password protected on a computer. The data will be kept until the successful completion of the study in January 2018 after which time it will be destroyed. My supervisor will also have access to the anonymised data. Any transcribed materials will only be available to my supervisor and myself; and the participants will not see these written records.

You and your child are free to withdraw from the study by informing me at any time during data collection and up to 4 weeks after the data are collected.

Information about confidentiality

The data that I collect (videos/ audio recordings/ pictures/ transcripts) may be used in an *anonymous* format in different ways. This may include:

- Being presented in academic presentations, papers or dissertation
- Presented at conferences and in journal articles.

The data will only be used for academic and research purposes.

I hope that you will agree to take part. If you have any questions about the study that you would like to ask before giving consent or after the data collection, please feel free to contact me by email XXXXXXX or by telephone on XXXXXXXXXXX, or the Chair of Ethics Committee via email education-research-administrator@york.ac.uk

This project has been reviewed by and received ethics clearance through the ethics committee in the Department of Education at the University of York. If you have any questions about this research, please in the first instance contact me or XXXXXXXXX. If you have any concerns about the conduct of this research, you may contact the Chair of the Ethics Committee, XXXXXXXXXXX.

If you are **not** happy to participate in the study, please complete the form below and return it to your child's science teacher.

Please keep this information sheet for your own records.

Thank you for taking the time to read this information.

Yours sincerely

Andrea Mapplebeck

'Oral teacher feedback in science classrooms'

Parent/Guardian opt-out form

If you do NOT permit your child to participate in the study, please complete this form and return it to your child's teacher within the next week. (Please print clearly)

I do NOT wish my child to take part in the research project.

Student's name: .....

Teacher's Name: .....

Parent's/Guardian's name: .....

Parent's/Guardian's signature: .....

Date……

Appendix 13

Student Study Information Sheet
'Oral teacher feedback in science classrooms'

Dear Sir/Madam,

My name is Andrea Mapplebeck and I am currently carrying out a research project to identify the types of dialogue that occur in science classrooms and how they help students to learn. I am writing to ask if you are able to take part in the study.

What would this mean for me?

The study will involve me as the researcher: Observing a sequence of science lessons from each of the teachers involved in the study.

Recording the science lessons with audio and possibly video equipment.
Photographing lesson plans and students' work.
Audio recording interviews with focus groups of students.
Audio recording interviews with the science teachers.

The interviews will take place during the normal school day at a time and in a place convenient to you in order that they do not cause disruption to the teaching schedule. The interviews will last a maximum of 30 minutes.

Anonymity

The data gathered (e.g. audio/video recordings of the lessons, audio recordings of the interviews, notes from observations, photos) will be stored by code number only known to me as the researcher. Any information that identifies you/your class/school will be stored separately from the data. The video footage will only be used during the data analysis and will not be shared with anyone.

Storing and using your data

Data will be stored securely and will be password protected on a computer. The data will be kept until the successful completion of the study in January 2018 after which time it will be destroyed. My supervisor will also have access to the anonymised data. Any transcribed materials will only be available to my supervisor and myself; and the participants will not see these written records.

You are free to withdraw from the study by informing me at any time during data collection and up to 4 weeks after the data are collected.

Information about confidentiality

The data that I collect (videos/ audio recordings/ pictures/ transcripts) may be used in an *anonymous* format in different ways. This may include:

- Being presented in academic presentations, papers or dissertation
- Presented at conferences and in journal articles.

The data will only be used for academic and research purposes.

I hope that you will agree to take part. If you have any questions about the study that you would like to ask before giving consent or after the data collection, please feel free to contact me by email XXXXXXX or by telephone on XXXXXXXXXXX, or the Chair of Ethics Committee via email education-research-administrator@york.ac.uk

This project has been reviewed by and received ethics clearance through the ethics committee in the Department of Education at the University of York. If you have any questions about this research, please in the first instance contact me or XXXXXXXXX. If you have any concerns about the conduct of this research, you may contact the Chair of the Ethics Committee, XXXXXXXXXXX.

If you are happy to participate please complete the form enclosed and return it to your science teacher.
Please keep this information sheet for your own records.

Thank you for taking the time to read this information.

Yours sincerely

Andrea Mapplebeck

'Oral teacher feedback in science classrooms'

Student Consent Form – Name:_____

Please initial/tick each box if you are happy to take part in this research.

I confirm that I have read and understood the information given to me about the above named research project and I understand that this will involve me taking part as described above. ☐

I understand that the purpose of the research is to identify the types of dialogue that occur in science classrooms and how they help students to learn ☐

I understand that data will be stored securely on a password-protected computer and only Andrea Mapplebeck will have access to any identifiable data. I understand that my/ my class and my school's identity will be protected by use of a code/pseudonym ☐

I understand that my data will not be identifiable and may be used:

in publications that are mainly read by university academics ☐

in presentations that are mainly read by university academics ☐

I understand that data will be kept until January 2018 after which it will be destroyed. ☐

I understand that I can withdraw my data at any point during data collection and up to 4 weeks after data is collected. ☐

I am happy for data to be collected by the following methods: ☐

- Lesson observations ☐
- Audio recordings of lessons ☐
- Photographs of students' work. ☐
- Audio recordings of interviews with the students. ☐

Appendix 14

Headteacher Study Information Sheet

'Oral teacher feedback in science classrooms'

Dear

My name is Andrea Mapplebeck and I am currently carrying out a research project to identify the types of dialogue that occur in science classrooms and how they help students to learn. I am writing to ask if you and your school are able to take part in the study.

What would this mean for me/my students/ my school?

The study will involve me as the researcher:

Observing a sequence of science lessons from each of the teachers involved in the study.

Recording the science lessons with audio and possibly video equipment.

Photographing lesson plans and students' work.

Audio recording interviews with focus groups of students.

Audio recording interviews with the science teachers.

The interviews will take place during the normal school day at a time and in a place convenient to the participants in order that they do not cause disruption to their teaching schedule. The interviews will last a maximum of 30 minutes.

Anonymity

The data gathered (e.g. audio/video recordings of the lessons, audio recordings of the interviews, notes from observations, photos) will be stored by code number only known to me as the researcher. Any information that identifies you/your school/students or staff will be stored separately from the data. The video footage will only be used during the data analysis and will not be shared with anyone.

Storing and using your data

Data will be stored securely and will be password protected on a computer. The data will be kept until the successful completion of the study in January 2018 after which time it will be destroyed. My supervisor will also have access to the anonymised data. Any transcribed materials will only be available to my supervisor and myself; and the participants will not see these written records.

You and any of the participants are free to withdraw from the study by informing me at any time during data collection and up to 4 weeks after the data are collected.

Information about confidentiality

The data that I collect (videos/ audio recordings/ pictures/ transcripts) may be used in an *anonymous* format in different ways. This may include:

- Being presented in academic presentations, papers or dissertation
- Presented at conferences and in journal articles.

The data will only be used for academic and research purposes.

I hope that you will agree to take part. If you have any questions about the study that you would like to ask before giving consent or after the data collection, please feel free to contact me by email XXXXXXX or by telephone on XXXXXXXXXXX, or the Chair of Ethics Committee via email education-research-administrator@york.ac.uk

This project has been reviewed by and received ethics clearance through the ethics committee in the Department of Education at the University of York. If you have any questions about this research, please in the first instance contact me or XXXXXXXXX. If you have any concerns about the conduct of this research, you may contact the Chair of the Ethics Committee, XXXXXXXXXXX.

If you are happy for your school to participate please complete the form enclosed and return it to me at our meeting.

Please keep this information sheet for your own records.

Thank you for taking the time to read this information.

Yours sincerely

Andrea Mapplebeck

'Oral teacher feedback in science classrooms'

Headteacher Consent Form

Please initial/tick each box if you are happy to take part in this research.

I confirm that I have read and understood the information given to me about the above named research project and I understand that this will involve my school taking part as described above. ☐

I understand that the purpose of the research is to identify the types of dialogue that occur in science classrooms and how they help students to learn ☐

I understand that data will be stored securely on a password-protected computer and only Andrea Mapplebeck will have access to any identifiable data. I understand that my school/my teachers/my student's identity will be protected by use of a code/pseudonym ☐

I understand that my data will not be identifiable and may be used:

in publications that are mainly read by university academics ☐

in presentations that are mainly read by university academics ☐

I understand that data will be kept until January 2018 after which it will be destroyed. ☐

I understand that I can withdraw my data at any point during data collection and up to 4 weeks after data is collected. ☐

I am happy for data to be collected by the following methods:

- Lesson observations ☐
- Audio recordings of lessons ☐
- Photographs of students' work. ☐
- Audio recordings of interviews with focus groups of students. ☐
- Audio recordings of interviews with the science teachers. ☐

Appendix 15

Teacher Study Information Sheet

'Oral teacher feedback in science classrooms'

Dear Sir/Madam,

My name is Andrea Mapplebeck and I am currently carrying out a research project to identify the types of dialogue that occur in science classrooms and how they help students to learn. I am writing to ask if you and your class are able to take part in the study.

What would this mean for me/my class/my students?

The study will involve me as the researcher:

Observing a sequence of science lessons from each of the teachers involved in the study.

Recording the science lessons with audio and possibly video equipment.

Photographing lesson plans and students' work.

Audio recording interviews with focus groups of students.

Audio recording interviews with the science teachers.

The interviews will take place during the normal school day at a time and in a place convenient to the participants in order that they do not cause disruption to the teaching schedule. The interviews will last a maximum of 30 minutes.

Anonymity

The data gathered (e.g. audio/video recordings of the lessons, audio recordings of the interviews, notes from observations, photos) will be stored by code number only known to me as the researcher. Any information that identifies you/your class/students will be stored separately from the data. The video footage will only be used during the data analysis and will not be shared with anyone.

Storing and using your data

Data will be stored securely and will be password protected on a computer. The data will be kept until the successful completion of the study in January 2018 after which time it will be destroyed. My supervisor will also have access to the anonymised data. Any transcribed materials will only be available to my supervisor and myself; and the participants will not see these written records.

You and any of the participants are free to withdraw from the study by informing me at any time during data collection and up to 4 weeks after the data are collected.

Information about confidentiality

The data that I collect (videos/ audio recordings/ pictures/ transcripts) may be used in an *anonymous* format in different ways. This may include:

- Being presented in academic presentations, papers or dissertation
- Presented at conferences and in journal articles.

The data will only be used for academic and research purposes.

I hope that you will agree to take part. If you have any questions about the study that you would like to ask before giving consent or after the data collection, please feel free to contact me by email XXXXXXX or by telephone on XXXXXXXXXXX, or the Chair of Ethics Committee via email education-research-administrator@york.ac.uk

This project has been reviewed by and received ethics clearance through the ethics committee in the Department of Education at the University of York. If you have any questions about this research, please in the first instance contact me or XXXXXXXXX. If you have any concerns about the conduct of this research, you may contact the Chair of the Ethics Committee, XXXXXXXXXXX.

If you are happy for you and your class to participate please complete the form enclosed and return it to me at our meeting.

Please keep this information sheet for your own records.

Thank you for taking the time to read this information.

Yours sincerely

Andrea Mapplebeck

'Oral teacher feedback in science classrooms'

Teacher Consent Form – Name:_____

Please initial/tick each box if you are happy to take part in this research.

I confirm that I have read and understood the information given to me about the above named research project and I understand that this will involve myself and my class taking part as described above. ☐

I understand that the purpose of the research is to identify the types of dialogue that occur in science classrooms and how they help students to learn ☐

I understand that data will be stored securely on a password-protected computer and only Andrea Mapplebeck will have access to any identifiable data. I understand that me/ my class and my school's identity will be protected by use of a code/pseudonym ☐

I understand that my data will not be identifiable and may be used:

in publications that are mainly read by university academics ☐

in presentations that are mainly read by university academics ☐

I understand that data will be kept until January 2018 after which it will be destroyed. ☐

I understand that I can withdraw my data at any point during data collection and up to 4 weeks after data is collected. ☐

I am happy for data to be collected by the following methods: ☐

- Lesson observations ☐
- Audio recordings of lessons ☐
- Photographs of students' work. ☐
- Audio recordings of interviews with the science teachers. ☐

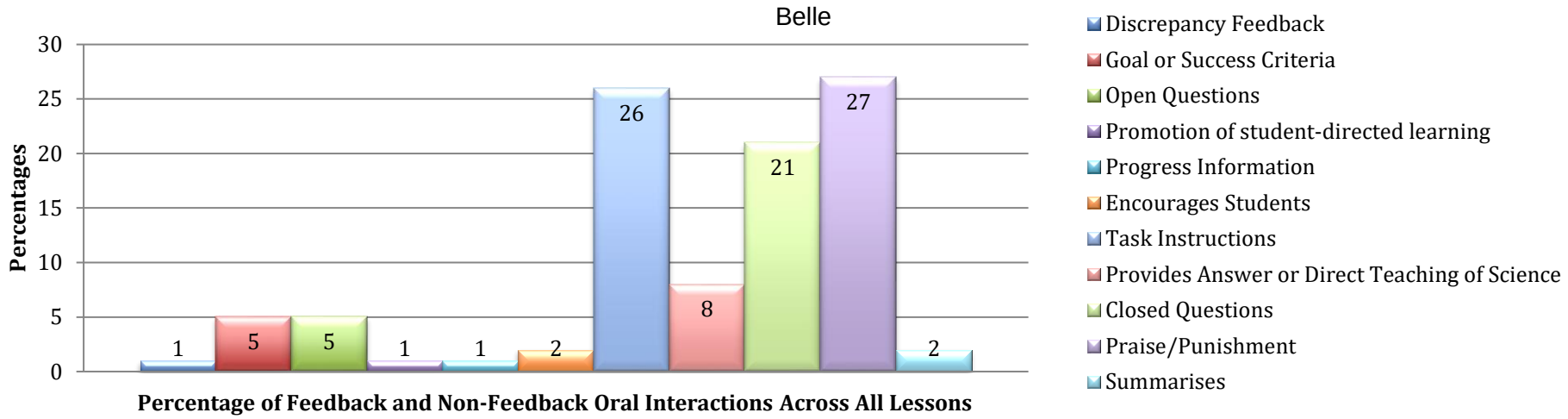
Appendix 16 - Coded lesson extract from Eric, Lesson 4

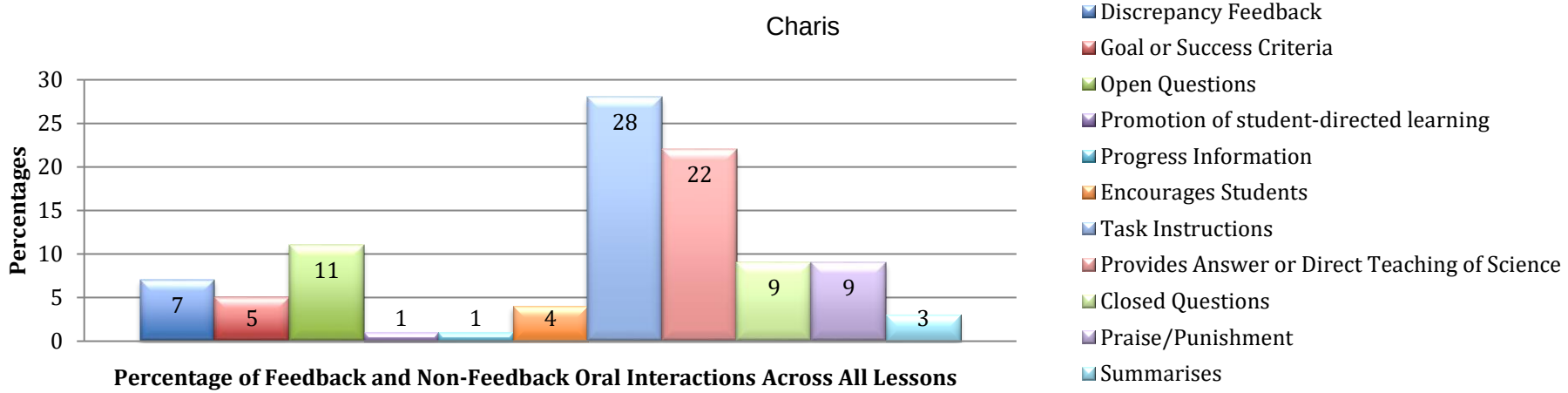
Lesson Extract	Oral Interaction Type
Eric: *'Warren can you tell the class about the time you committed suicide, in relation to this the third question'*	Task instruction to student
Eric: *'Warren what did you do that was so terrible?*	Open question getting student to analyse own performance.
Warren replied describing how they had said that a sodium and chloride metal compound was a molecule with covalent bond instead of saying they were ionic.	
Eric: *'I don't think you meant it was a covalent bond, and why did we term that to be suicide?'*	Open question getting student to analyse own performance.
Warren then describes that it was a chemical error as they are not covalently bonded.	
Eric: *'Chemical error means four marks but you lose all four if you use one word, molecule'*	*Discrepancy* identifying the error
Eric: *'But Warren had another go at that to develop his work, Warren can you read to us your third one please.*	Task instruction
Eric: '*Let's see how many marks Warren would get, ok listening close'*	Success criteria
Warren reads out his answer to the third question that the class had been working on.	
Eric: *'Can you read that again I am just trying to figure out'.*	Task instruction to individual
Eric: *'Class can you listen carefully.'*	Task instruction to class
Eric: *'I am wondering if there was one point missing here'*	Success criteria
Warren reads out answer again adding in extra details.	

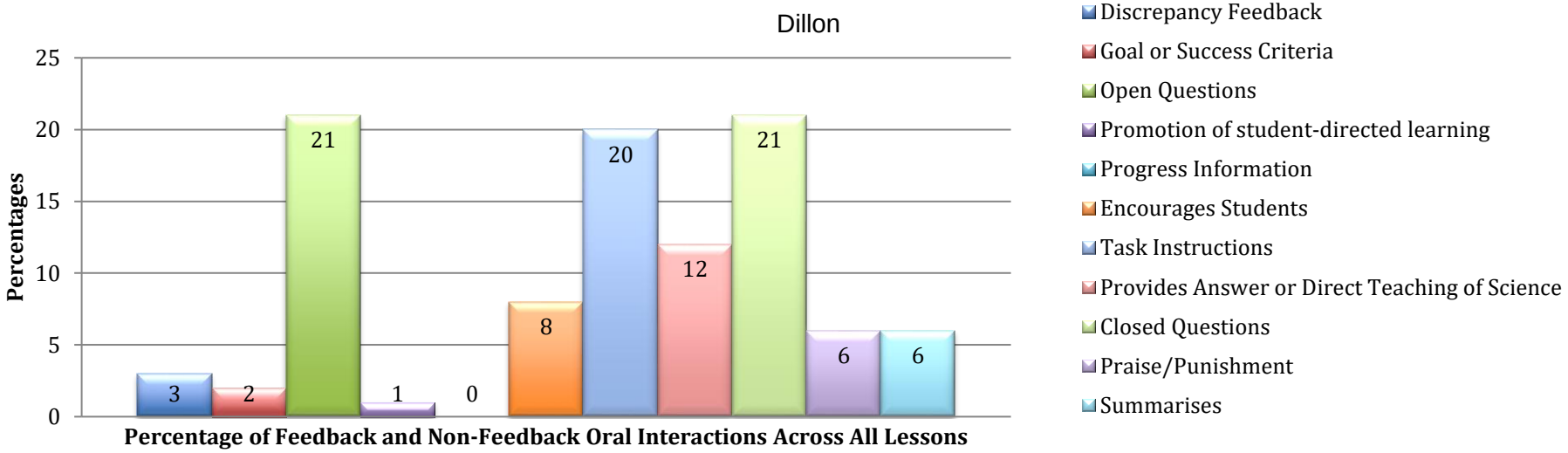
Lesson Extract	Oral Interaction Type
Eric: 'Could you tell us what you got the points for?'	Open question
Warren answers indicating the size of the charges	
Eric: 'Yes so we said magnesium 2+ and sodium is 2+'	Summarises
Eric: 'And then you said therefore?'	Open question probing for understanding
Warren described how the charges were between the metal and non-metal.	
Eric: 'Yes so there's your first mark.'	Interaction about success criteria
Eric: "And therefore what did you say as a result of that?'	Open question probing for understanding
Warren then discusses stronger electrostatic attraction.	
Eric: 'Between the oppositely charged ions.'	Summarising point made by student
Eric: 'Which did you say had the higher melting point?'	Closed question as no reasoning ascertained
Warren replies with magnesium.	
Eric: 'So that's three marks, you didn't get the fourth'	Interaction about success criteria
Eric: 'Can you tell people what you think you may have missed?'	Open question probing understanding.
Eric looks at another member of the class and says: 'Ethan'	Encourages student to join in and add ideas
Ethan discusses the amounts of energy needed	
Eric: 'Yes so you need to link it into energy at the end like Ethan said'.	*Discrepancy* identifying the error and next step

Lesson Extract	Oral Interaction Type
Warren then affirms and explains what was needed in additions.	

Appendix 17 Individual Percentage Distributions of All Oral Types



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Percentages
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15
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20
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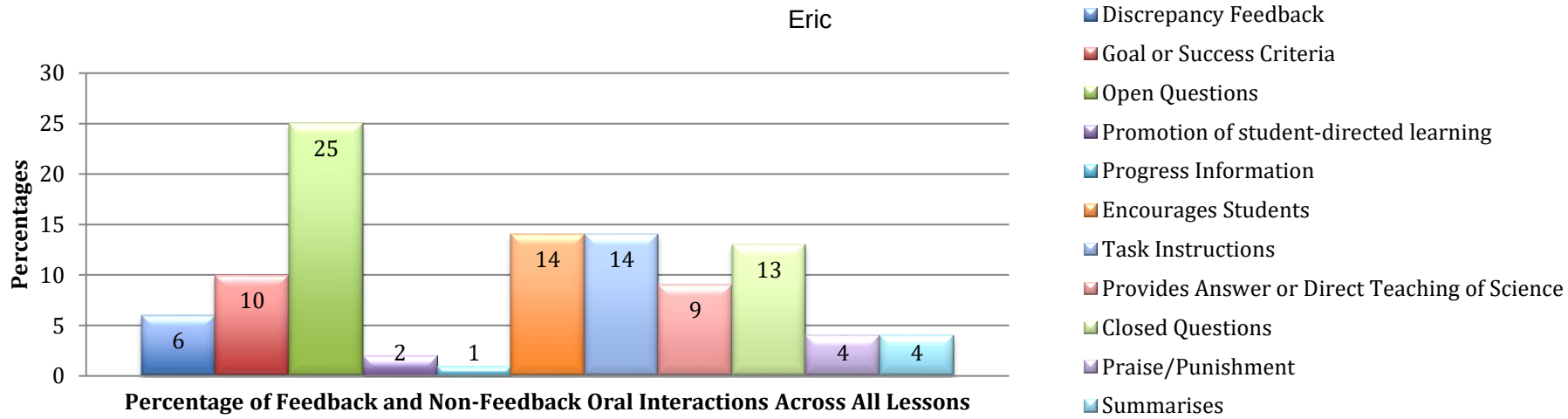
21
6
6
Percentage of Feedback and Non-Feedback Oral Interactions Across All Lessons
Discrepancy Feedback
Goal or Success Criteria
Open Questions
Promotion of student-directed learning
Progress Information
Encourages Students
Task Instructions
Provides Answer or Direct Teaching of Science
Closed Questions
Praise/Punishment
Summarises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Percentages
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20
15
10
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0
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10
25
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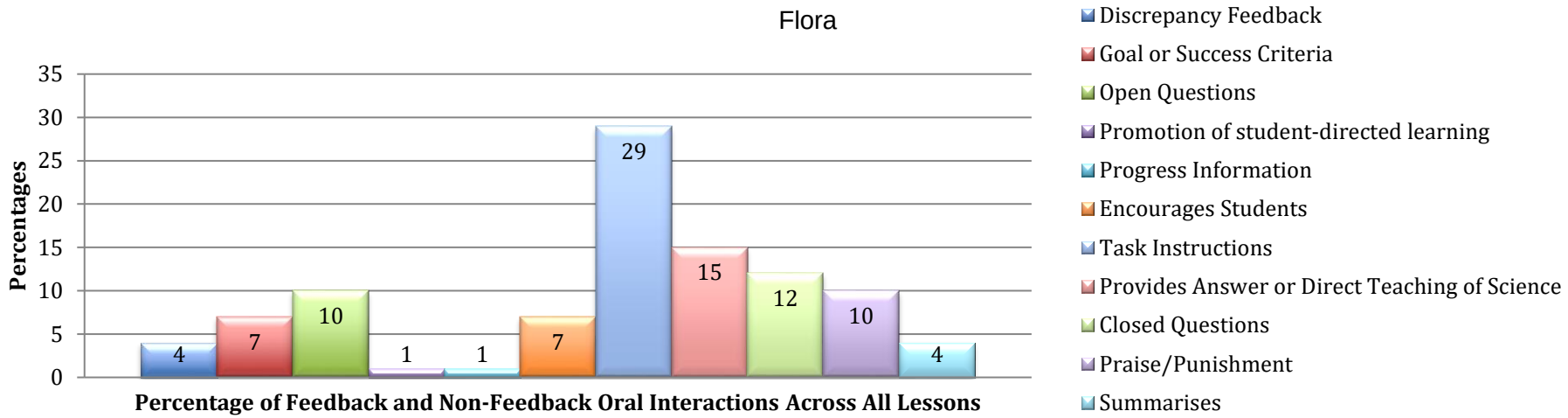
14
14
9
13
4
4
Percentage of Feedback and Non-Feedback Oral Interactions Across All Lessons
Discrepancy Feedback
Goal or Success Criteria
Open Questions
Promotion of student-directed learning
Progress Information
Encourages Students
Task Instructions
Provides Answer or Direct Teaching of Science
Closed Questions
Praise/Punishment
Summarises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Percentages
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10
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4
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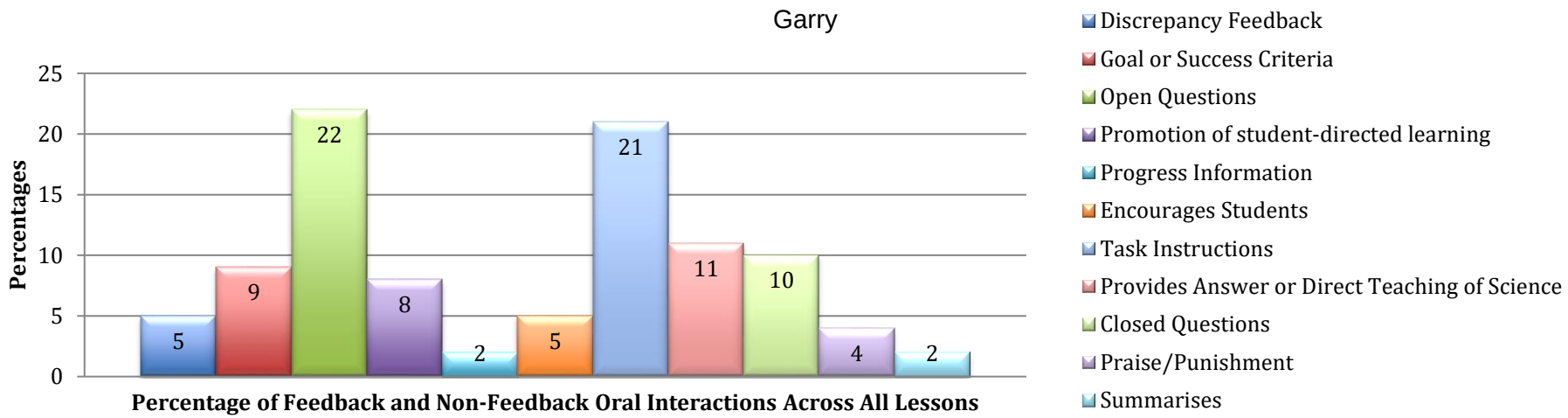
4
Percentage of Feedback and Non-Feedback Oral Interactions Across All Lessons
Discrepancy Feedback
Goal or Success Criteria
Open Questions
Promotion of student-directed learning
Progress Information
Encourages Students
Task Instructions
Provides Answer or Direct Teaching of Science
Closed Questions
Praise/Punishment
Summarises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Percentages
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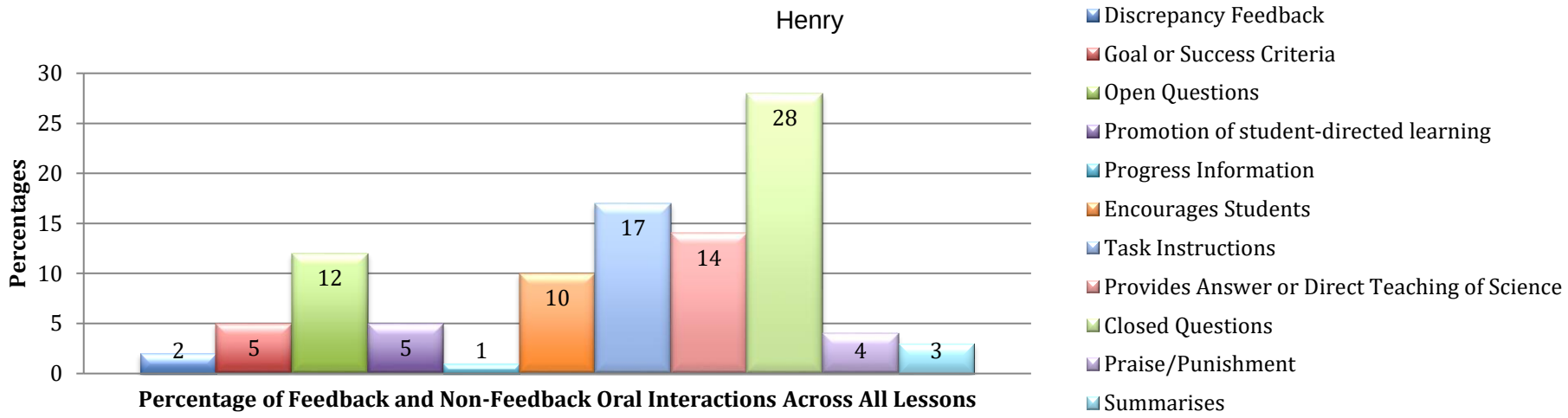
Percentage of Feedback and Non-Feedback Oral Interactions Across All Lessons
Discrepancy Feedback
Goal or Success Criteria
Open Questions
Promotion of student-directed learning
Progress Information
Encourages Students
Task Instructions
Provides Answer or Direct Teaching of Science
Closed Questions
Praise/Punishment
Summarises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Percentages
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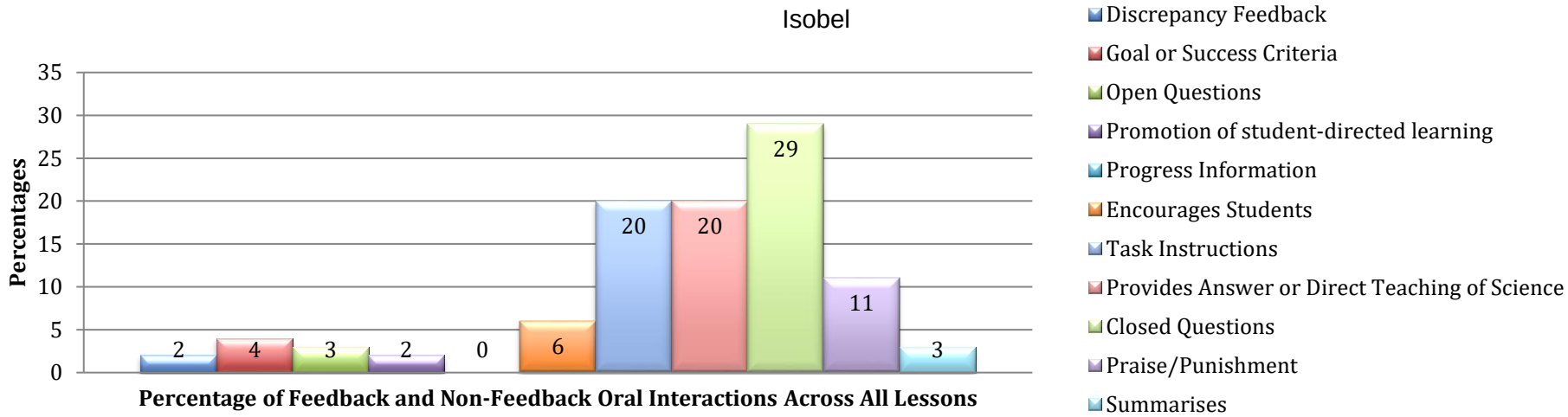
3
Percentage of Feedback and Non-Feedback Oral Interactions Across All Lessons
Discrepancy Feedback
Goal or Success Criteria
Open Questions
Promotion of student-directed learning
Progress Information
Encourages Students
Task Instructions
Provides Answer or Direct Teaching of Science
Closed Questions
Praise/Punishment
Summarises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Percentages
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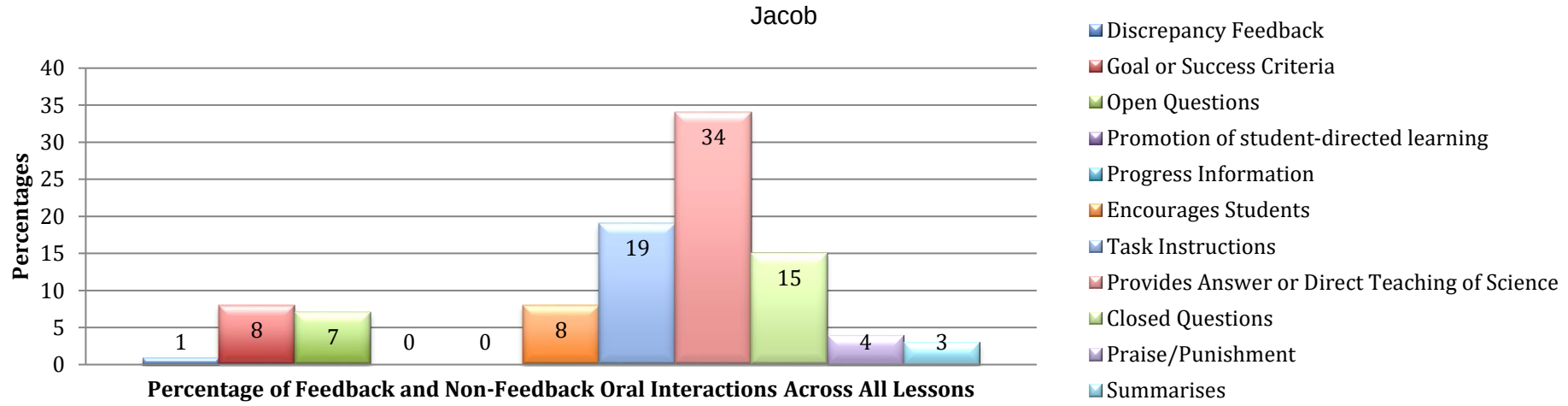
Percentage of Feedback and Non-Feedback Oral Interactions Across All Lessons
Discrepancy Feedback
Goal or Success Criteria
Open Questions
Promotion of student-directed learning
Progress Information
Encourages Students
Task Instructions
Provides Answer or Direct Teaching of Science
Closed Questions
Praise/Punishment
Summarises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Percentages
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34
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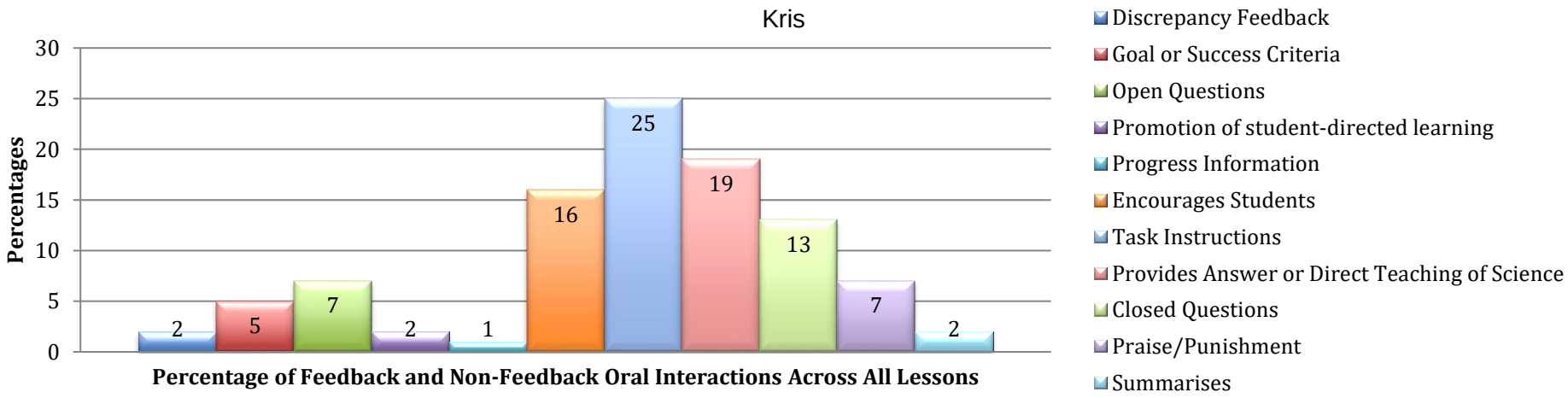
3
Percentage of Feedback and Non-Feedback Oral Interactions Across All Lessons
Discrepancy Feedback
Goal or Success Criteria
Open Questions
Promotion of student-directed learning
Progress Information
Encourages Students
Task Instructions
Provides Answer or Direct Teaching of Science
Closed Questions
Praise/Punishment
Summarises


Kris
Percentages
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Percentage of Feedback and Non-Feedback Oral Interactions Across All Lessons
Discrepancy Feedback
Goal or Success Criteria
Open Questions
Promotion of student-directed learning
Progress Information
Encourages Students
Task Instructions
Provides Answer or Direct Teaching of Science
Closed Questions
Praise/Punishment
Summarises

Abbreviations

AfL	Assessment for Learning
ARG	Assessment Reform Group
BERA	British Educational Research Association
CPD	Continuing Professional Development
DfE	Department for Education
EEF	Education Endowment Foundation
EFL	English as a Foreign Language
GCSE	General Certificate of Secondary Education
IRE	Initiation-Response/reply-Evaluation
IRF	Initiation-Response/reply-Feedback
IRP	Initiation-Response/reply-Prompt
ISA	Investigative Skills Assignment
KWLH	what I Know, what I Wonder, what I have Learnt, How I have learnt
LA	Local Authority
MKO	More Knowledgeable Other
OECD	Organization for Economic Cooperation and Development
Ofsted	The Office for Standards in Education
SCCO	Student-centred-content-orientation
SPSS	Statistical Package for the Social Sciences
TCCO	Teacher-centred-content-orientation
UK	United Kingdom
UNESCO	United Nations Educational, Scientific and Cultural Organisation
Y	Year

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