

Characterising the Dialogicity of Classroom Talk: Theoretical and Empirical Perspectives

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ABSTRACT

The central focus of this study is to characterise classroom talk (CT) from the Dialogicity perspective and relate this characterisation to pupils' learning. It aims particularly to reflect on and develop the concept of Dialogicity as a theoretical perspective for characterising the nature of CT in relation to both teaching and learning. The study developed an analytical framework to analyse CT based on further characterising the Authoritative and Dialogic types of talk as defined by the communicative approach of Mortimer and Scott (2003). Data was generated by videotaping grade nine Omani science classes and probing the conceptual understanding of samples of pupils from these classes using bubble dialogue sheets and focus group discussions. This exploration was carried out in two stages separated by a short teacher training intervention designed to promote the practice of dialogic talk.

The results demonstrated a quite big change in CT practice between the two stages, with more incidents of Dialogic talk in the second stage. Detailed analysis revealed a number of features characterising the Authoritative and Dialogic communicative approaches. Furthermore, it demonstrated different kinds of CT that were to be judged as Authoritative and others as Dialogic. This has resulted in viewing each type of talk along three general levels of high, mid and low. Consequently, the study has developed the communicative approach to a 'multi-level Authoritative-Dialogic' model. Deeper reflection on this model, as characterising CT Dialogicity at the empirical level, led to propose the 'less-more' dialogic model to approach CT Dialogicity at the theoretical level. The study argues that the continuity view of Dialogicity that this theoretical model is based on might be helpful in developing the concept of Dialogicity as a perspective in approaching the nature of CT.

In investigating the relationship between CT Dialogicity and learning, the study looked into learning as a process and as a product. General results pointed to the superiority of Dialogic talk in supporting pupils' learning over Authoritative talk, in the terms of pupils' engagement, cognitive level of questions and responses and the conceptual understanding following from the teaching. However, the study argues that it is not possible to establish a constant claim on this superiority because the comparison between the two types can be approached differently, depending upon which of their levels are being compared. Alternatively, it suggests that the relationship between CT Dialogicity and learning is better approached in the light of the continuity view within the 'less-more' dialogic model. Accordingly, different claims on the advantages of more dialogic talk over less dialogic in supporting pupils' learning have been suggested. In addition, the results illustrated a resonance between the pupils' conceptual understanding and difficulties and what happened in the preceding teaching.

In summarising the relationship between CT Dialogicity, teaching and learning, the study asserts that learning is closely connected to the CT characterisation from the Dialogicity perspective, and does not stand in isolation from teaching. Different implications for research and teacher training have been raised in view of the study's methodological practices and findings.

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LIST OF ABBREVIATIONS

CT: Classroom Talk

BE: Basic Education

CA: Communicative Approach

I/A: Interactive/Authoritative

NI/A: Non-Interactive/Authoritative

I/D: Interactive/Dialogic

NI/D: Non-Interactive/Dialogic

Bd: Bubble dialogue

FG: Focus Group

TI: Training Intervention

(A-D): (Authoritative-Dialogic)

1 CHAPTER 1: SETTING THE SCENE

1.1 Shifts in concern

Throughout the world, understanding of learning has gradually moved from traditional views with the learner as a passive participant, to constructivist views where learners actively engage in making meaning of the information through interacting with it (Duit & Treagust, 2003). In my country Oman, the whole system of education has been greatly influenced by this transition. Under a new system of education introduced in 1998, there is a great emphasis on the role of pupils in constructing knowledge, and the role of the teacher in handing them the responsibility for their own learning. Teaching science under this system is planned to be collaborative, activity/inquiry-based, and aims generally to teach communication, thinking and learning skills (MOE, 2004a, 2006). Consequently, the classroom has taken on a new image that is more interactive and cooperative, including activities that involve individual, pair, small group or whole class work (ibid). Such an image has been practised by many educational systems around the world long before the Omani system. In spite of this, international research still refers to the under-representation of dialogic practice in teaching, in which pupils contribute to the progression of their understanding by being given the chance to refine and work on their own ideas (Alexander, 2000, 2004; Driver, Asoko, Leach, Mortimer, & Scott, 1994; Nystrand, Lawrence, Camoran, Susie, & Long, 2001; Skidmore, 2000, 2004, 2006; Wells, 1999). It has also been claimed that a large part of the classroom talk is just conducted to maintain the social structure of the teacher/pupil relationship (Lemke, 1990) as pupils are not involved intellectually in building ‘the scientific story’ (Mortimer & Scott, 2003). Alexander (2008) summarises the situation, stating strongly that:

“talk which in an effective and sustained way engages children cognitively and scaffolds their understanding is much less common than it should be. Teachers rather than learners control what is said, who says it and to whom. Teachers rather than learners do most of the talking. And, as many UK and US researchers have consistently found, one kind of talk predominates: the so-called ‘recitation script’ of closed teacher questions, brief recall answers and minimal feedback which requires children to report someone else’s thinking rather than to think for themselves, and to be judged on their accuracy or compliance in doing so (Tharp and Gallimore 1988). This script is remarkably resistant to efforts to transform it. ‘When recitation starts’, notes Martin Nystrand, ‘remembering and guessing supplant thinking.’ (Nystrand *et al* 1997, p 6).” (Alexander, 2008b, p. 93)

But then, it is commonly agreed how critical and important the quality of classroom talk is to pupils’ learning and developing understanding, implying consequently that certain kinds of talk need to be prompted in teaching practices, and that research needs to pay attention to investigating this issue:

“The readiest way of working on understanding is often through talk, because the flexibility of speech makes it easy for us to try out new ways of arranging what we know, and easy also to change them if they seem inadequate. Not all kinds of

talk...are likely to contribute equally to working on understanding...It is clearly important to consider what kinds of discussion contribute most to working on understanding” (Barnes, 2008, p. 5).

Bringing together the foregoing discussion puts into sharper focus two main points that initiated this study:

- new basic education in Oman is based on a pupil-centred philosophy which is planned to adopt inquiry and cooperative approaches in teaching and learning science. These approaches have literally brought the roles of the teacher and pupils in the process of making meaning into question.
- research, specifically in science education, refers to insufficient dialogic practice in science classes, and certainly there should be some wide-ranging or context-dependent details that can illuminate this whole issue.

Discussing the specifics of these points is what comprised my first concern, which was to probe into Omani science classes to examine the nature of the discursive interaction taking place: what are its features? Does it entail dialogic practice? To what extent does it reflect a pupil-centred approach? What are the roles of teachers and pupils in such an interaction?

The next step was to survey the literature on the issue, exploring: what has been written about classroom talk and dialogic practice in teaching? What is dialogic talk? How can it be investigated? and such questions that the literature is expected to help with, before starting working on a typical study. However, this provided the first impetus to shift the concern of the study. In searching the literature for the nature of classroom talk in terms of its dialogicity - that is, searching for what has been described and conceptualised as dialogic talk and dialogic practice and what has *not*¹ - I got confused with the explication of dialogicity in the literature. I found it difficult to ascertain the position of:

1. dialogic talk in the context of other different labels of classroom talk, such as exploratory talk, argument, discussion, scaffolded dialogue, inquiry; types that seem to interrelate with dialogic talk in meaning and in research.
2. dialogic talk in the context of other educational levels, in its relation to what is described as ‘dialogic teaching’ and ‘dialogic education’.
3. dialogic talk in the context of theoretical-empirical duality, questioning whether approaching ‘dialogic’ theoretically is different from defining it for empirical investigation or not.

Related then to defining dialogic for empirical investigation was to look for the approach to discourse analysis; how can we understand the different approaches to discourse analysis

¹ Things can be understood through their opposites, explaining what they are by describing what they are not.

presented in literature? And what is the approach through which the empirical investigation of dialogic talk is to be performed? Going further into this raised another concern; pupils' learning. Given the existing literature, it seems challenging; thinking about how to include the investigation of learning as part of the characterisation of classroom talk (henceforth CT) within the approach to discourse analysis to be implemented.

All of these questions led eventually to shifting the concern of the study from examining the nature of the discursive practice in Omani science classrooms in terms of its dialogicity (*i.e. how dialogic is the observed Omani CT?*), to investigating the Dialogicity² of CT itself (*i.e. what is dialogic talk and what is it not, mainly in relation to the above three recognised contexts?; what are the characteristics of CT to be judged as dialogic or not?; does CT differ in how dialogic it is, and if so, how?*) using the Omani context just to provide data of CT to be analysed and characterised. A big focus also goes to investigating how the pupils' learning appears to follow from the observed teaching. Putting these issues together, the study focuses on exploring CT Dialogicity within both teaching and learning.

Having this in mind then, 'Dialogicity' as a term is used in this study generally as a descriptive conceptualisation of CT in relation to its characterisation as being dialogic or not, and/or how dialogic it is. Defining dialogic talk and detailing its characteristics is expected then to shape more clearly the meaning and use of Dialogicity, as a theoretical perspective in approaching the nature of CT. The study begins by establishing what there is in the literature about dialogic talk, and follows it by analysing generated data of CT. Refinement and concluding characterisation of the term Dialogicity at the CT level is to be resolved at the end of this report, while discussing and reflecting on the results of the empirical study in the light of the insights provided by the literature.

Hence, the nature of this study is directed primarily to contributing to the international research in this area of characterising the nature of CT in general, and in relation to its Dialogicity in particular; rather than being planned to be a description or evaluation of the nature of CT in the practice of a certain context; that is the Omani context.

² Dialogicity is capitalised as it is considered the phenomenon investigated through the study.

1.2 Purpose of the study, and main steps of research

Based on these shifts in concern, the main purpose of this study is to characterise CT from the Dialogicity perspective and to relate this characterisation to pupils' learning. In doing so, the study looks particularly to reflect on and develop the concept of Dialogicity as a theoretical perspective for characterising the nature of CT in relation to both teaching and learning. Hence, the study's aims cover two main parts:

1. The first relates to analysing science CT from the Dialogicity perspective by characterising it within dialogic/not-dialogic classification. This involves drawing on and refining existing conceptual tools to develop a framework for analysing the talk.
2. The second relates to investigating the relationship between CT Dialogicity and learning. This involves looking into the pupils' learning and following it back to the performed CT characterisation.

Addressing the main purpose within these two parts involves both theoretical and empirical steps, which are as follows:

- review critically the literature on existing perspectives of dialogic talk, focusing specifically on the three aforementioned contexts (section 1.1) recognised as areas of lack of clarity in 'dialogic' literature;
- use this review as a basis for developing a new analytical framework to probe the Dialogicity of CT;
- apply the analytical framework to analysing some CT;
- examine the pupils' learning arising from the analysed CT;
- take the findings from this analysis of empirical data, and reflect on the characterisation of CT from the Dialogicity perspective in light of the relevant literature.

Some refinement of these steps of research is presented towards the end of the literature review chapter in light of the insights gained (section 2.4). Research questions appear later on at the beginning of the methodology chapter (section 5.1).

1.3 Structure of the thesis

The thesis consists of ten chapters, including this introductory one that sets out the broad outlines of the study by explaining its concern and main aims. The literature review in Chapter 2 explores different issues related to the three themes identified above (section 1.1). In the first part, I explain the study's view of the position of CT in relation to both teaching and learning. Part two explores the conceptualisation of 'dialogic' in the literature by looking into how it has been defined and investigated. This review proceeds to justify

eventually the need to develop a detailed analytical framework to further characterise the authoritative and dialogic classes of the communicative approach of Mortimer and Scott (2003). The third part reviews the historical development of the approaches to discourse analysis and concludes by outlining four bases to guide the development of the analytical framework. Following part three, the chapter closes by refining the main steps of research introduced in this chapter (section 1.2).

Chapter 3 describes the development of the analytical framework. It gives an overview of the parts it consists of and explains their different elements in detail. It closes by offering an example of application to demonstrate how the framework works in analysing excerpts of CT.

Chapter 4 is a very short one concerning general features of the educational context in Oman. It precedes the methodology chapter to give some idea of the context in which the data was generated, to help the reader to follow the planning of the empirical research of this study.

Chapter 5 outlines the research methodology by setting out first the research questions, and explaining the research approach and method. It then describes the research design built on generating data for the two aspects of teaching and learning by videotaping the teaching of Omani science teachers and examining the conceptual understanding of samples of pupils from these classes. Data was generated in two stages separated by a training intervention planned to promote dialogic talk. Details of this intervention in addition to the implemented techniques of video recording and focus group discussions are then presented. This is followed by a description of the two processes of data generation and analysis, and comment on the issues related to trustworthiness and ethical considerations.

Chapters 6, 7 and 8 all present the data analysis of two cases. Chapters 6 and 7 offer the analysis of data in case one from the first and second stages, respectively. The focus in these chapters goes first to the discourse analysis of the recorded CT to characterise the authoritative and dialogic communicative approaches. Attention is directed then to analysing the pupils' conceptual understanding of the taught scientific topics, and following it back to the teaching.

Two analysis chapters have also been written on case two. However, the limited space has imposed the exclusion of these chapters from the main report of the thesis. They are included in the appendices, with a general summary of their content in Chapter 8.

In Chapter 9, a number of issues are highlighted in relation to the main aims of the study. It is divided into three parts. In the first part concerning CT Dialogicity in relation to teaching, a development of the communicative approach as an empirical tool to characterise CT from

the Dialogicity perspective is suggested. Further and deeper reflection on the results in the light of relevant literature leads then to argue about a theoretical model in approaching the nature of CT from the Dialogicity perspective. The second part summarises and reflects on the results on pupils' learning in connection to CT Dialogicity. In the last part, I highlight the relationship between teaching and learning, and how they are connected by CT Dialogicity.

In Chapter 10, the final chapter, a summary of the study's findings in view of the research questions is presented, followed by some comments on its contribution and implications for research and teacher training.

The next chapter reviews the literature in the specified areas pointed out in sections 1.1 and 1.2.

2 CHAPTER 2: LITERATURE REVIEW

Based on the Vygotskian articulation of the relationship between thought, language and the social and cultural context, it has become standard to embrace the central function of language in the construction of knowledge within a sociocultural tradition. It is almost from this starting point that classroom talk (CT) studies began to capture more interest in educational research, based on such a view of the connection between language, teaching and learning:

“The communication system that a teacher sets up in a lesson shapes the roles that the pupils can play, and goes some distance in determining the kinds of learning that they engage in” (Barnes, 2008, p. 2)

Subsequently, CT has been shaped into different categories with different names labelling types of it, where certain types (e.g. recitation, presentational talk) have been observed to dominate more than others (e.g. argument, dialogue, exploratory talk), and where the others have been claimed to be more supportive of pupils’ learning than those which dominate. Among these categories is ‘dialogic talk’, a type that has gained increasing interest in CT studies - influenced greatly by Bakhtin’s contribution - and this has extended to broader levels of dialogic teaching and dialogic education. As explained in the previous chapter, my earlier survey of the literature on dialogic talk has contributed to shifting the concern of the study towards exploring Dialogicity at the level of CT, because of what seems a confusing handling of ‘dialogic’ in relation to the previously mentioned aspects of Dialogicity (section 1.1):

- dialogic talk in relation to other similar categories describing the type of CT;
- dialogic talk in relation to dialogic teaching and dialogic education;
- dialogic talk in relation to how it is defined for theoretical approach and/or empirical use;
- dialogic talk in relation to discourse analysis approaches;
- dialogic talk in relation to how it is connected to learning.

This review aims to explore these premises and to reorganise the related thoughts, for the sake of gaining a deeper understanding of the Dialogicity of talk that would guide the CT analysis throughout this study. In doing so, the review is divided into three parts, each of which has its focus of interest:

- Given the aforementioned view of talking in relation to teaching and learning, I attempt in the first part (section 2.1) to explore this view through the theoretical accounts and findings presented by relevant studies in the science education field (2.1.1). I then go into more speculative exploration of how CT is to be realised in relation to teaching and learning in accordance with the orientation of this study

- (2.1.2). More attention is then directed to specifying views of learning, as the characterised CT Dialogicity is to be connected to the findings on learning (2.1.3).
- In part two (section 2.2), the review is most specific to ‘dialogic’ premises. It begins by presenting some of the definitions of ‘dialogic’ (2.2.1), and explains how their interrelation might confuse our conception of it. It continues by emphasising the interference between dialogic talk and dialogic teaching, by reviewing some of the studies on ‘dialogic’ in practice (2.2.2). This line of review progresses to justify, eventually, the implementation of Mortimer and Scott’s (2003) communicative approach (henceforth **CA**) in this study (2.2.3). I continue by discussing the particulars of this approach to reflect on the need to further characterise its classes within a broader analytical framework for analysing the nature of CT from the Dialogicity perspective.
 - The aim of the last part (section 2.3) is to set out the bases on which the analytical framework is to be built. In doing so, the section begins by defining the approach to realising discourse in terms of its Dialogicity (2.3.1). It reviews then the historical development of the approaches to discourse analysis (2.3.2). Determined by the outcomes of this review and some insights from the first two parts, this section closes by presenting the bases that are to guide the development of the analytical framework (2.3.3).

2.1 Part 1: Talking, teaching and learning

More than anything, the classroom is most likely to be a wordy place, or as Edwards and Furlong (1978, p. 10) put it; “The most obvious characteristic of CT is that there is so much of it”. CT has been described as providing ‘a medium for teaching and learning’ (Edwards & Mercer, 1987, p. 20), “a teacher’s main pedagogic tool” (Mercer & Littleton, 2007, p. 2), a tool for “cultural and pedagogical intervention in human development and learning” (Alexander, 2008b, p. 93). Indeed, talking about CT cannot but be connected to teaching and learning. However, trying to figure out this connection in a more defined way seems to be a confusing and difficult task that research is still struggling with. Basically, “In much research on the processes of teaching, learning and cognitive development, there has been little recognition that these three elements are connected by dialogue” (Mercer & Littleton, 2007, p. 135).

I try in this section to follow this issue within the needs of this study to identify a theoretical proposition on CT in relation to both teaching and learning. Before going on with this, it might be useful first to shed light on the scene related to talking in science education research: what does this research say about it, and how does it appear in the practice of teaching and learning?

2.1.1 CT in science education research

In science education, CT has been closely connected to the language of science through a sustained debate that has resulted in viewing learning science as learning to talk science, where talking science means *talking about science* (refers mainly to CT about the taught scientific subject matter) on the one hand, and *doing and communicating science* (*observing, describing, comparing, classifying, analysing...etc*) using the different forms of the language of science on the other hand (see Lemke, 1990 for more details). In many studies, therefore, talking science has been characterised by the rich synthesis of linguistic, mathematical, practical, visual and gestural representations of the language of science (Lemke, 1990, 2001; Roth, 1995, 2005; J Wellington & Osborne, 2001). Based on this broad view of the language of science, Lemke (1990) described science talk in secondary classes in terms of two categories; organisational, in which people are interacting within some particular set of expectations about what will happen next; and thematic, in which people construct complex meanings about a topic by combining words and other symbols. This articulation of the language of science can be compared to the meaning of discourse in educational research relating the 'language-in-use' to its social context. Gee (2005) differentiated between 'little d' discourse and 'big D' Discourse, where *discourse* refers only to the stretches of language-in-use while *Discourse* turns also to the "non-language stuff" (p.7) including several ways of interacting, reading, writing, believing, using symbols and tools. Although the focus of this study is on the 'little d' discourse in its spoken form and directed to the talking about science, it is not possible to free ourselves from the other non-verbal and the non-language stuff, as it constitutes the social, historical and cultural context in which this talking is taking place.

Nevertheless, regardless of the various orientations in approaching the conception of the language of science, the different studies seem to gather around a profound belief in the importance of the spoken language for teaching and learning, and the impact that its quality can have on both processes. The way the teacher "orchestrates the talk of the lesson" to develop the scientific story being taught is regarded by Mortimer and Scott (2003, p. 1) as a key feature in any science lesson. Throughout their book about meaning-making in science classrooms, they affirm their view that talk plays a central role in the process of making meaning, which in itself is central to learning. Combining together thought and language as a cognitive tool for human development, Vygotsky (1978, p. 26) wrote: "Children solve practical tasks with the help of their speech, as well as their eyes and hands". In this respect, Sutton (1992, p. 40) wrote: "words steer perceptions both positively and negatively, and also they influence what people do or do not do as well as what they see or miss seeing" (p. 41). Accordingly, he noted that learning science involves learning to see in new ways:

- seeing the salt as dissolving and not just disappearing...
- seeing the circuit amongst the tangle of wires, seeing the plastic as insulator, seeing the need for continuity in a circuit... (p. 41)

Besides, he attempted to examine the link between the two aspects of thought and language by looking into how words act on human minds, and how have they done so in the growth of scientific ideas. He clarified three convictions in his view of the relation between thought and words:

- The words chosen by any speaker or writer help to crystallise his or her thoughts, and subsequently steer that person's perceptions
- Sometimes - but not always - one person's words elicit in somebody else a corresponding shift of perception
- Thoughts of this kind are invariably accompanied by some aspect of feeling, which is no less important than their intellectual effect (p. 3)

Specific to CT studies in science education are those which focus on the argumentative, reasoning and explanatory discourse, primarily through small group discussion. Many studies have been conducted to investigate the place of this spoken type of discourse in science, and how to enhance its quality and role in the pedagogy of school science (e.g. Alexandre, Rodri'guez, & Duschl, 2000; Driver, Newton, & Osborne, 2000; Erduran, Simon, & Osborne, 2004; D. Kuhn, 1991; P. Newton, Driver, & Osborne, 1999; Osborne, Erduran, & Simon, 2004; Osborne, Erduran, Simon, & Monk, 2001; Simon, Erduran, & Osborne, 2006; Simon & Maloney, 2007). In the exemplified studies, the researchers recommend strongly the practising of argumentation in teaching science, writing, for example, that:

“science education without argument is like a book without a plot: in danger of becoming a tale told by an idiot, full of sound and fury but ultimately incomprehensible” (Osborne et al., 2001, p. 69).

"appropriate classroom activities and their associated discursive practices are the means to socialise the learners into the norms of scientific argument which might help them to gain deeper understanding of scientific ideas and claims" (Driver et al., 2000, p. 288)

Generally, the value of argument in science and science education has been discussed based on two positions; philosophical and cognitive ones, reflecting the value of including students in talking *about* science;

a) Philosophically, science is seen as a construction of knowledge rather than a collection of facts. Even though knowledge is constructed from experimental designs, observations and evidence, appropriateness of designs, deduction from observations and interpretation of evidence are not absolute or unproblematic. The knowledge derived is actually open for

arguing about and re-examining its validity and accuracy:

“The most important, valued kinds of knowledge are neither certain beyond question nor the arbitrary product of personal opinion. Instead they are the product of effortful cognitive work in which possibilities are generated, contemplated and evaluated, and reasoned judgments reached” (D. Kuhn, 1991, pp. 264-265)

b) From the cognitive perspective, argumentative, explanatory discourse in science not only helps students to develop conceptual understanding, but it also helps them to develop their beliefs, reasoning, reflective analytical skills and their abilities to understand and think critically:

“If pupils are genuinely to understand scientific practice, and if they are to become equipped with the ability to think scientifically through everyday issues, then argumentative practices will need to be a prominent feature of their education in science” (P. Newton et al., 1999, p. 556)

Also related to this line of research are those studies which directed their investigation to the construction of knowledge and understanding through talk and interaction. Neil Mercer is prominent with his work in this area, often related to science education (as is Douglas Barnes in language education). His successive studies are based on reinforcing the view of knowledge as socially constructed; implementing and promoting, accordingly, a sociocultural approach to studying the role of language in constructing ‘shared knowledge’ (e.g. Mercer, 1995, 2000; Mercer & Littleton, 2007). He talked about ‘ground rules’ (Edwards & Mercer, 1987) and ‘language techniques’ (Mercer, 1995) used by both the teacher and pupils in developing a common shared version of educational knowledge. A major part of his work has been directed to examining student-student CT. He, with other colleagues, conducted several studies on investigating the role of this type of interaction in learning and development (e.g. Mercer, 1994, 1996; Mercer & Wegerif, 1999; Mercer, Wegerif, & Dawes, 1999). This is an important issue in CT research that this study could not focus on, although some data has been generated. However, some of this data has been used in analysing the pupils’ conceptual understanding, as will be evident in the relevant chapters (Ch. 6, 7 & 8).

So then, what do the studies on CT in science education tell us about CT in practice?

In an analysis of field notes and recordings from 60 classes, in biology, chemistry, physics and earth science courses, Lemke (1990) found that recitation, distinguished by the three-part exchange structure of the ‘triadic dialogue’ (I-R-E) is persistent in classrooms. He also claimed that a large part of the classroom’s conversation is just conducted to maintain the social structure of the teacher/student relationship, where the I-R-E exchange does not attain the planned teaching aims, as students are not participating effectively in managing the process of meaning-making. Moreover, in examining the ‘place of argumentation in the pedagogy of school science’ in England, Newton et al (1999) found that the CT in observed

secondary science classes was largely dominated by the teacher, and opportunities for students to contribute to the process of constructing the knowledge were few and far between. Similarly, Roth et al (1999) conducted a study to look at the interaction between students and their experienced teacher in a physics class. They demonstrated that because of the lack of interaction, the participants experienced different worlds, describing the physical world in different ways. Consequently, the researchers declared that "In this situation, learning is difficult if not impossible" (p. 73), and recommend that students and their teachers need to participate in a common discourse. Furthermore, Aleixandre et al (2000) talking about CT as "Procedural display activities" described them as social habits in classrooms, in which the exchanged conversation is performed without a purpose for students (p. 758). In response to such situations, Driver et al (2000, p. 308) declared strongly that "students need to be given a greater voice in lessons".

From another perspective, Sutton (1992), in his analysis of the two activities characterising science - guesswork (forming theories) and checkwork (experimental testing of consequences, building up evidence for or against) - argued that:

“Science education up to the present day has been dominated by a careful training for the second stage, and hence a sceptical approach to language has predominated....For the education of the general citizen however, the systems for checking knowledge are not really so overwhelmingly important, and experience of them can hardly count as ‘education’ if the learners never really grasped the ideas in the first place. It is to enhance the appreciation of ideas that we need a less Spartan attitude to language in science teaching” (p. 33)

Eleven years later, Mortimer and Scott (2003, p. 1) also express their worry about the "under-representation of the scientific story" in science lessons, which are dominated by growing emphasis on activities, experiments and practical work. Concerning CT in relation to the language of science, Shamos (1995) and Wellington and Osborne (2001) stated that the language of science constitutes a barrier in any attempt to make students talk about science. By discussing some studies, Wellington and Osborne (2001) stated that non-technical words (e.g. random, relative, quantitative, excess), as well as technical and specialist terms of science (e.g. power, inertia, torque, field) pose difficulties while trying to understand their precise meanings or using them to appreciate scientific ideas. Moreover, the fact that words do not carry unique meanings was declared by Mortimer and Scott (2003) to add more complexity to the process of meaning-making in science classes, as this means that different meanings are generated in different contexts.

It is very obvious then, that significant empirical investigations have been carried out to capture the nature of talk in the practice of teaching in science education and other areas of subjects (some of which will be presented in due course in section 2.2). In spite of the dominant agreement on the importance of spoken language, such studies persistently report a

limited teaching use of the type of talk which engages pupils in learning. Recent studies in the area are actually focusing on how the quality of talk seems to influence learning and development of thinking (e.g. Mercer & Dawes, 2008; Scott., 2008), and promoting the advantage of teaching children how to talk, how to take part in dialogue, exploratory talk; types of talk that are believed through empirical investigation to support children's learning and development of cognitive and intellectual skills (e.g. Mercer, Dawes, Wegerif, & Sams, 2004; Mercer & Wegerif, 1999).

However, research still tells us that this area of talking in relation to learning specifically, and in relation to teaching and learning together, needs more empirical exploration:

- "Overall preliminary results indicate that collective reasoning is influenced strongly by the nature of teaching..., a finding that can be unpacked further in future studies to examine how engagement in argumentation discourse can improve science teaching and learning?" (Erduran et al, 2001, p. 932)

- "a missing crucial component of this body of research is any significant evidence demonstrating that engaging in discursive problem-solving activities leads to enhanced cognition - one of the major goals of any type of education" (Osborne et al, 2004, p. 1016)

- "although there has been a good deal of research on classroom talk, we do not think that enough attention has been given to the relationship between the quality of the talk and learning outcomes" (p. 2); "There has even been considerable research on teaching, sometimes under the headings of didactics and pedagogy, that has given little attention to the active role of the learners, to what they achieve from their participation in encounters with teachers or from their interactions in classrooms with each other" (Mercer & Littleton, 2007, p. 135)

Most specific to the studies on the nature of the talk in terms of its Dialogicity - the interest of this study - there is also this concern of deficiency in evidence and empirical investigation with regard to teaching and learning, as will appear later in section 2.2. In the next subsections, I will proceed in the attempt to explore theoretically the position of CT in relation to teaching and learning, to go more deeply in following the view to understanding learning in the first place.

2.1.2 CT and the controversial relationship between teaching and learning

In his response to arguments in the literature about the limited applicability of theories of learning to educational practice, Ausubel (1968) described theories of learning and theories of teaching as "interdependent" and needed together in building "a complete science of pedagogy" (p. 14). He clarified that although theories of learning cannot prescribe how to teach, they do offer "the most feasible point of departure for discovering general principles of teaching" given that "the facilitation of learning is the only proper end of teaching" (p. 12). Yet in 2007, Mercer and Littleton still claim that:

”Strange as it may seem to anyone involved in education, there is a long-established line of experimentally based psychological research on the processes and theory of learning that has taken no account of the processes of teaching” (p. 135)

It might be, consequently, that at the level of practice, bringing together theories of learning and theories of teaching has been a controversy of education. On the one hand this is due to the undeniable complexity of the two processes. On the other hand, it is part of a broader debate on theories of learning, and on how these might be worked out through teaching. A common practice in bringing the two together would be, generally, that on the basis of theories or models of learning, writers propose models of teaching whose aims, content, pedagogy, and assessment meet broadly the principles of learning of the chosen model/theory (e.g. Cobb, Confrey, diSessa, Lehrer, & Schauble, 2003; Kabapinar, Leach, & Scott, 2004). This is still not a straightforward procedure. In the context of discussing the constructivist model of learning, for example, Millar (1989) argues that:

“A constructivist model of learning does not ... logically entail a constructivist model of instruction ... this must be so or the constructivists would face a major problem in explaining how most people who might be said to have an understanding of science have come to acquire it. For it is very clear that most of us who think we ‘understand’ some science concepts did not arrive at this understanding by experiencing teaching programmes structured on constructivist lines” (p. 589).

He suggests, rather, that instead of attaching a constructivist model of learning to a particular model of instruction, it is more practicable to figure out the consequences of the constructivist model of learning, such as ‘active learning’. For this consequence then, the teacher can utilise whatever pedagogy is believed to promote and encourage active involvement in learning. He went on to initiate the issue of “the ‘weight’ to be given to children’s ideas compared with the accepted scientific view”, raising the point of the merit of “children taking away from science lessons ideas that diverge radically from the accepted ones” (p. 590).

In fact, various and thorough lines of argument on this issue can be found in the literature - take those on teaching design experiments research, for example (e.g. Brown, 1992; Cobb et al., 2003; Leach, Ametller, & Scott, 2009), given also that it is a major determinant within the debate on the relationship between research and practice (which resulted in emergent strands of research such as educational action research and evidence-based practice, for example). It is out the scope of this study to detail these arguments, but it is in its interest to define a position of CT in relation to teaching and learning.

Ausubel (1968) stated that principles of teaching need to be scrutinised with regard to the practical context in which the formal instruction takes place. The classroom, in this sense, is a primary setting in which principles of teaching are to be applied, following some principles of

learning. In the classroom setting, likewise, spoken language constitutes a fundamental source for the information intended to be taught by the teacher and learned by students. For instance, the practice of Constructivism has recommended that teaching needs to acknowledge the starting points of students, stressing active - rather than rote - learning, using discussion and argument. This points to a significant role given to the type of talk in translating the Constructivism, as a theory of learning, to practice. In his book 'The Guided Construction of Knowledge', Mercer (1995) gave examples of how talk is used through teaching to guide the construction of 'shared' knowledge (i.e. learning) using different strategies and tools in different cultures. As pointed out previously, it is difficult, if not impossible, to find a study on CT that would not attempt to draw some sort of a picture for CT against the background of teaching-learning.

Drawing such a picture, however, can be open to different interpretations and various approaches. It would be more sensible then, to take a pragmatic stance in approaching this position in view of the aims of this study of characterising CT Dialogicity and following it to pupils' learning. This stance would entail, in fact, two assumptions, and imposes two requirements:

- It assumes that CT, in regard to teaching, is more than a semiotic tool, intervening strategy or one kind of pedagogy. Rather, it is to be seen as an act of teaching, in itself, that is open to any tools, strategies or pedagogies that are to be 'delivered' through this act.

This requires defining the approach to characterising CT as an act of teaching in terms of its Dialogicity; the bases to be built around, and the detailed constituents that form it. This is a task to be initiated in the second part and to be followed on in the third part of this review.

- It assumes that learning, as a process, will be influenced by CT as an act of teaching, whether it (learning) is to be supported or not. Knowledge appearing to be produced by this process is to be seen as a product, highly 'accomplished' by CT as an act of teaching.

This requires defining the nature of the knowledge that is believed to be 'accomplished' by CT as an act of teaching. Basically, this requires defining the theory in approaching learning. If learning is to be individualised and/or contextualised (socialised, historicised & culturised) for example, researching CT as an act of teaching needs to be individualised and/or contextualised, in turn. This is what the next subsection will begin with; following the theory in approaching learning and the nature of constructed knowledge.

2.1.3 Learning along theoretical-empirical duality

In most of today's research, the bases of Constructivism are taken for granted; that in any learning context, learners will have their prior ideas and conceptions. So learning is looked at as a (re-) construction of knowledge through which learners, actively, make sense of the world by constructing meanings and linking new information with past experience and everyday life. Different theories of learning have originated from this position of knowledge as (re-) constructed rather than transmitted; a view that in one of its most important implications advertises an active rather than a passive role of learners. In spite of some recent critiques of the position of Constructivism in denying the view of transmission of knowledge; accused therefore of disregarding cultural and traditional practices that, for long, have contributed to the development of knowledge (see for example; Bowers, 2007), Constructivism is widely accepted and has constituted the bases of different theories of learning.

In this respect, I find the scheme proposed by Geelan (1997) to characterise the constructivist writing a powerful tool to organise the many forms of theories of learning stemming from Constructivism. His scheme outlines Constructivism along two axes: the Personal-Social axis, and the Objectivist-Relativist axis. Although the different forms have not been explicitly organised in the scheme diagram, the argument presented by Geelan suggests the distribution in fig. 2.1 of some forms of Constructivism. According to the scheme, the forms differ in their view of learning, as a construction of knowledge; whether individualistic (personal/cognitive) or social, as well as their view of the nature of constructed knowledge, whether objectivist or relativist. The literature is rich with profound and extended arguments on the two views along each axis. To put it simply, in my articulation:

- In the individualistic sense, learning is seen to be shaped inside the individual mind through adaptive encounter with the physical world, and therefore understanding is individual in origin. In the social sense, learning is seen to be shaped by the individual's interaction with other people through adaptive encounters with the social and cultural world that s/he shares with others, and therefore understanding is social in origin.
- In the objectivist sense, there is one version of knowledge in a certain context, whether this knowledge is to be seen as what is 'true', what is correct, or the one which works. In the relativist sense, there are multiple versions of knowledge, not a unique one, whether this knowledge is to be seen as what is 'true', what is correct, or the one which works.

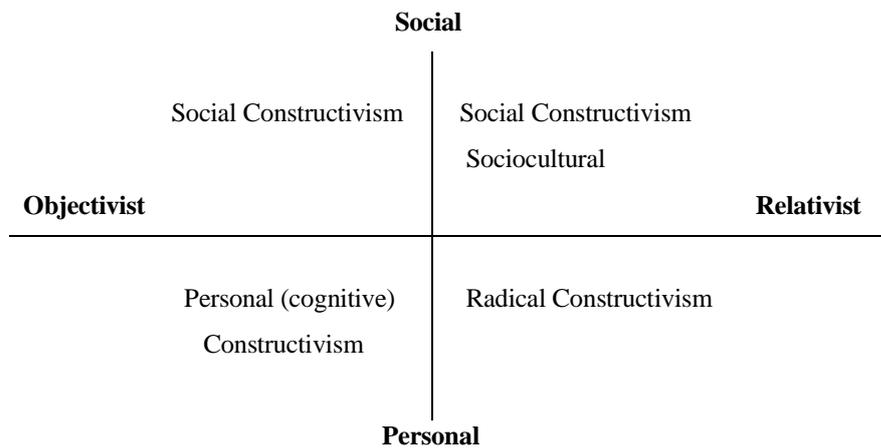


Figure 2.1: Geelan's (1997) scheme to organise forms of Constructivism

Assigning different published papers on researching learning to the four quadrants, as Geelan has done, shows that according to mere historical development, the forms on the right, belonging to the relativist tradition along the personal-social axis, are the most recent ones. Although being conferred by philosophy and sociology of science (e.g. Gregory, 1988; T. Kuhn, 1970a, 1970b), the relativist perception of the nature of knowledge was to dominate and set aside the objectivist view, under the influence of the 'big' theories of science in the 20th century as the literature reflects (see for example; Taber, 2009). With 20th century science, there was not just the deterioration of classical theories and models, long believed to be the 'true' and 'one' version of knowledge in explaining the physical world (e.g. Newtonian mechanics), but also the emergence of theories (e.g. Einstein's relativity, quantum mechanics) that themselves refer to the relativity of the knowledge constructed about the physical world, as it is; relative to the observer constructing it in relation to his frame of reference, probable and not certain ... etc. Indeed, the relativistic perspective of knowledge was to shape and to be shaped by the view of the nature of science, and how science works, to doubt the 'reality' of knowledge, and to re-direct, consequently, theories of learning.

Yet, one can simply take a shortcut to believing in and understanding this relativity in terms of the bases of Constructivism. As no individual and no interaction, is replicated, then no construction of knowledge can be imitated and no version of knowledge can be fully reproduced. And simply, for different individuals, and different contexts of interaction, there are different versions of knowledge, and therefore, knowledge cannot be but relativist. But then, there is the constructed knowledge that works in explaining the physical world; one version that can be claimed true in its context and within its frame of reference. People can also agree over one version of knowledge to be considered as shared (Mercer, 1995), taken-as-shared (Cobb, 1991), common (Edwards & Mercer, 1987), consensual domains (Taber, 2009). In the classroom setting then, there is the relativistic knowledge reflected by the teacher and the pupils' constructed versions of the one version of the knowledge set by

the curriculum, considered as objective.

Perceiving the tension between individual and social views to learning seems different, though, from the objectivist-relativist one. In one way, the implications of the individual-social argument on educational practice seem far more influential than the objectivist-relativist one, although interrelated. In another way, while the argument over the nature of knowledge in recent forms of Constructivism seems to be resolved towards the relativist pole, the view of learning appears to go in both directions, of the individual and social. The most recent theories of Sociocultural and Radical Constructivism are adopting social and individual views, respectively. This, in my view, can be looked at in terms of different perceptions of the relation between individual and social than the objectivist-relativist one (fig. 2.2). The two processes of learning are interdependent, inseparable and each is embedded in the other, as learning in its essence is both individual and social. For the views of knowledge, the relation appears as the objectivist view is embedded in the relativist one, and not the other way around.



Figure 2.2: Learning as Individual and Social (left), and Knowledge as Objective and Relative (right)

At the theorising level, it is noticeable that those who adopt one view to learning would not deny the other view, as much of the talk in related studies is promoting a complementary view of looking at learning as both individual and social (e.g. Driver et al., 1994; Leach & Scott, 2003; Mercer & Littleton, 2007). At the empirical level, however, the usual action is to follow one adopted view in accordance with the specified research aims and questions, to be regarded then as the theoretical position of the named study. In this sense, studies on classroom interaction are more likely to declare a theoretical position based on a view of learning as social in origin³, specifying the analytical approaches to be, for example; sociolinguistic (e.g. Sinclair & Coulthard, 1975), sociocultural (e.g. Edwards & Mercer, 1987; Mercer & Littleton, 2007; Mortimer & Scott, 2003), or social semiotic (e.g. Lemke, 1990).

It seems unconvincing also to pay total attention to social interaction in analysing learning and disregarding the individual effect, or the opposite, as learning in its essence is both individual and social, as Barnes (2008, p. 10) puts it:

“Teachers teach classes but pupils learn as individuals, each constructing slightly different versions of the meanings made available during the interchanges shared

³ It is worth mentioning that such a statement of position is hardly found with regard to the view of constructed knowledge, whether objectivist or relativist.

by the whole class and by the teacher. Both the shared constructions and the individual struggle to reinterpret are essential”

Most crucially, the two processes are inseparable:

“In normal human life, communicative activity and individual thinking have a continuous, dynamic influence on each other” (Mercer, 2000, p. 9)

I believe indeed that the more precisely the individual process of learning is known, the more precisely the social process can be known, and the opposite is true- taking this as a property of the phenomenon of learning. This means that better understanding of one process can lead to better understanding of the other, and to better understanding of the phenomenon of learning as a whole. I believe, hence, that in investigating learning at the empirical level, it is better to attempt to measure simultaneously both individual and social processes. The researched topic would define then the process of learning that is more likely to get more of the researcher’s attention.

In this sense, investigating pupils’ learning in relation to the classroom interaction is expected not only to focus on the social pole, but also to attempt to look into the individualistic effect. However, the confusing thought in this context - of trying to connect pupils’ learning to the teaching, focusing specifically on CT - is how the individualistic view of the construction of knowledge can be envisaged within an approach to language, that it “has developed as a form of social interaction” (Markova, 1992, p. 52). It is not strange then that research on the role of language in the construction of knowledge is overwhelmingly ‘social-bound’⁴. Responding to this thought invokes in my mind a picture of CT as a bidirectional path between two destinations (only in the visual sense) of teaching and learning, and stimulates the question of, how can the individualistic view be operated along this path?

Although answering this question is important to the research methodology, the truth is that I do not have a clear answer to it. What this study will be trying to do, however, is to analyse CT from the social position, but to attempt to capture the individual contributions when and as possible. Based on this, I consider the study’s underpinning approach as sociocultural in the sense recommended by Mercer and Littleton (2007) in their speculation of a sociocultural theory of learning and development that is applicable to classroom talk. According to their proposal, this sociocultural theory “must take account of the relationship between three levels of human activity: the cultural/historical, the psychological and the social/interactional” (p. 20), describing the psychological level as “individual learning and cognitive development’. The main key to doing this, and which this study is based on, is conducting a deep analysis of generated data, taking into account the context of the talk, which would be expected to relate

4 As it is so, I believe it is neither possible nor justifiable to free ourselves from this approach to language; this study hence is inspired by the dialogically-based, social cognitive approach to language and mind, as will be explained in section 2.3.1.

to the three levels. This is in addition to planning the study's design and research tools, taking the individualistic factor into consideration (see Chapter 5: Methodology).

More to the point, it is useful to think about what is to be included in looking at learning and the nature of the knowledge to be constructed. In defining learning, Wellington (2006) wrote:

“Roughly speaking, learning occurs when experiences cause a relatively permanent change in someone's knowledge, attitudes, beliefs, perceptions or behaviour” (p. 114)

This study aims to investigate learning from the ‘understanding’ or ‘making meaning’ stance. However, having in mind the above general definition, I realise that looking at the ‘knowledge stuff’ concerning the pupils’ understanding cannot be separated entirely from the ‘non-knowledge stuff’, related to the teacher and pupils’ attitudes and behaviours, for example. Principally,

“Thinking and feeling are not as separate as we often treat them” (D. Newton, 2002, p. 4)

Characterising CT Dialogicity can be approached from such points of examination, depending on how much the available data and its analysis can provide. In investigating pupils’ learning, therefore, there will be the attempt to look into the pupils’ developing understanding reflecting the ‘knowledge stuff’ (see sections 6.4, 7.4, 8.4 & 8.6), supported and complemented by following any indicators on the ‘knowledge’ or ‘non-knowledge’ stuff that the data of CT and its analysis can provide (see sections 6.3.3, 7.3.4, 8.3.3 & 8.5.2). (For more clarification of the study’s approach to investigating learning, see section 9.2.)

2.1.4 Summary

- In the first section, a brief review of CT studies in science education research was presented, establishing that: a) CT is important to the processes of teaching and learning; b) knowledge is constructed and understanding is developed through CT; c) the quality of CT has an impact on pupils’ learning, and d) the teaching use of the kind of CT that engages the pupils in their learning is limited.
- Focusing the discussion then on approaching the position of CT within teaching and learning, has resulted in two underlying assumptions to guide this study; a) CT as an act of teaching, and b) learning as influenced by CT as an act of teaching.
- In the third section, views of learning and knowledge were explored within the theory of Constructivism. It has been argued that although studies on classroom interaction usually implement a social perspective to learning, there is the need to operate also the individual one. This is the approach that this study will attempt to follow .

The next section is focused on the ‘dialogic’ premises in characterising the nature of CT.

2.2 Part 2: Dialogicity at the level of CT

I begin in this part to explore more directly and in greater depth the issue of Dialogicity. As pointed out in the previous chapter, 'Dialogicity' is used in this study as a descriptive conceptualisation of the nature of CT in relation to its characterisation as dialogic or not (refer to section 1.1). The task of this part is to search the literature for types of dialogic CT, to identify how dialogic talk has been conceptualised and investigated by different studies in the science education area, supported by some from the area of language education.

2.2.1 Confused 'dialogic'

Through the history of education, dialogue has acquired multiple dimensions that have been initiated with different contexts and purposes. Dialogue has been described, philosophically, according to the "Socratic method", deliberated, politically, within Dewey's concept of democracy, and utilised, socially and pedagogically, by Freire as a problem-posing education for breaking away from the illiteracy of the oppressed as well as their 'silence'. As much as the multiple context-dependent dimensions of dialogue have contributed to its functional richness, they have widened its scope to result sometimes in unclear articulation for what is described as 'dialogic'.

Dialogue is normally used in daily life with the meaning; "Dialogue is a reciprocal conversation between two or more entities" (Wikipedia, 2010); hence interrelating semantically with other synonyms (e.g. talk, conversation, discourse, discursive/verbal interaction) in sharing the verbal communicative aspect. In some educational literature as well, dialogue has been connected to this 'everyday' meaning. For example, in describing the exchange structure of I-R-E in the teaching approach of recitation, Lemke (1990) used the term 'triadic dialogue', to describe the structure of a verbal exchange of talk. Likewise, Newton et al (1999), in distinguishing between two types of argument in light of the number of participants, used the terms 'monologic argument' and 'dialogic argument'. In both significant studies, dialogue/dialogic is used to refer only to the verbal exchange facet, excluding its distinctive feature that differentiates it from the other mentioned synonyms. This distinctive feature resides, in fact, in its original characterisation in the Greek word *dialogos*, where *dia* means 'through' or 'between' and *logos* refers to 'meaning' or 'thought' (Burbules, 1993). This characterisation implies that more than a merely verbal exchange of words, dialogue is an exchange of meanings between people by which individualistic ideas are explored, elaborated, reflected on and developed. Nevertheless, this is also a meaning used in daily life, most specific to describing the talk in contexts (e.g. political, cultural or educational) where it is intended to refer to negotiations and exchange of ideas. This meaning indeed is the most persistent in educational studies concerned with researching CT

in relation to dialogue and dialogic practice, with reference to Bakhtin's contribution most frequently. Recently, Rupert Wegerif (2007), while talking about the different meanings of 'dialogic' interpreted in literature from Bakhtin's writings, referred to this meaning of exchange of ideas; naming it as 'pertaining to dialogue'. At the level of spoken discourse, he talked about this meaning in addition to another interpreted one of 'dialogic' as an epistemological frame. Wegerif described the meaning of dialogic as 'pertaining to dialogue', as a dictionary and default everyday meaning that distinguishes dialogue "from social conversations that are not inquiries on the one hand or monologues on the other hand" (2007, p. 14). He claimed that the recent use of dialogic in educational studies within this interpretation has deprived the technical term of 'dialogic' from its potentiality and richness, because it is utilised in the "contexts where other terms like 'collaborative learning' or 'discussion' or 'social interaction' or 'community of inquiry' were previously used without any new depth of meaning being added" (p. 14). Nevertheless, this study is based on providing a more descriptive and explorative account on how this meaning can be utilised empirically to characterise CT and follow the implications of this characterisation, which is to give 'dialogic as pertaining to dialogue' more in-depth meaning.

For now though, it would be more proper to go on with the other interpretation that Wegerif referred to as 'dialogic as an epistemological paradigm', advocated largely by theorists of Dialogism (e.g. Linell, 2003; Rommetveit, 1992). He clarified that in perceiving dialogic as an epistemological frame, there is no existence of monologic as all the meaning is dialogic in nature. Even in having a monologue with oneself, different voices of different thoughts interact to build a reasonable meaning. The monologue in itself is an "illusion of power, ... it is not a reality but the impression that authoritative voices try to give that they are speaking a simple unquestionable truth that cannot be challenged" (p. 17). It is in fact that theorising about Dialogicity with reference to Bakhtin would usually entail a display of his view of any utterance as dialogical in nature. Morson and Emerson (1990) articulated this view by stating that all the utterances are dialogical in terms of addressivity, responsivity and genre-belongingness, as each utterance is directed to another body or thing, comes as a response to the other's situation or utterance, and belongs to the same genre of the other. The heart of such interpretation is derived from and focused on (at the same time) a dynamic and open view of meaning; the view that constitutes a main principle in the theory/school of 'Dialogism'; summarised by Linell (2003) into three key words of 'interaction, contexts, and linguistic-communicative construction' (p. 3), where the meaning of utterance is:

"dialogically constituted, made in dialogue (cognition and communication), with reference to the world and against the background of the world, which is then dialogically appropriated and dialogically recognized" (p. 3)

However, this view of ‘intrinsic dialogic to any utterance’ is accompanied, in these same theorists’ accounts, with argument on the differences between discourses in relation to their level of Dialogicity, as ‘less or more dialogic’. Subsequent to the one level in which all utterances are regarded as dialogic, Morson and Emerson, for example, argued that, according to Bakhtin, the discourse can be seen less or more monological or dialogical in relation to the multi-voicedness and openness of the utterance. From a similar perspective, but in a slightly different interpretation, Linell (2003) talked about monological vs. dialogical discourses, where the monological can be seen as the product of ‘monologising’ activities that yet “have an established position also in a dialogically conceived and constituted world ” (p. 13). This perception of ‘more or less dialogic’ seems, let us say, to legalise ‘dialogic as pertaining to dialogue’. In other words, the interpretation of dialogic as an ‘epistemological paradigm’ can be seen as of broader level, having the potential to embody the interpretation of dialogic as ‘pertaining to dialogue’, as this meaning is just part of it.

Nevertheless, both of these interpretations have been criticised by Wegerif (2007) as presenting dialogic as only a means to knowledge construction, and responsible, hence, for an “understanding of education as about the construction of an identity of some kind” (p. 28). He, in response, suggests what he describes as a social ontological interpretation of Bakhtinian ‘dialogic’; according to which dialogic, for a theory of education, is better to be realised as an end in itself. It should not be a ‘means to an end’ of building knowledge, developing skills, or even constructing identity. It is, as he sees it, an opening of a space of dialogue; a space of learning, and the role of the education is to move the learners into that space. Following the same line of argument of the interlink between the meanings of ‘dialogic’ with reference to Bakhtin, it is to be suggested also that Wegerif’s promoted interpretation of dialogic as an end in itself is of a broader level in relation to the two. The interpretation of ‘dialogic’ as pertaining to dialogue is embedded then in the interpretation as epistemological paradigm, and the two are embedded in the ‘dialogic’ as an end (fig. 2.3).

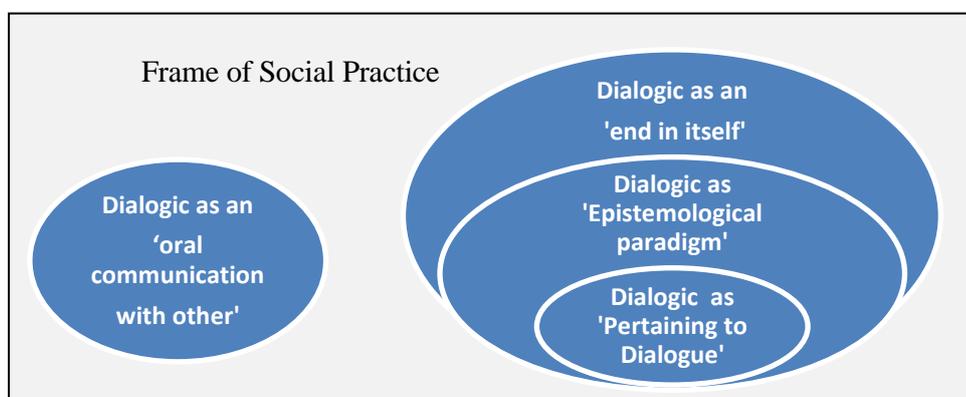


Figure 2.3: Interlink of meanings between ‘Dialogic’ definitions

This means that the smallest, yet the basic unit in putting the three interpretations together in the visual representation in fig. 2.3, is derived from viewing ‘dialogic’ as an exchange of meanings. In this sense, ‘dialogic as an oral communication with other’, comes outside this visual representation. Its relation to this representation comes, in my view, from being part of a frame of social practice that the three interpretations are understood within. With such understanding, questioning these meanings shall not be isolated from where and how they are utilised, as will be clarified next.

In summary then, ‘confused dialogic’ seems to come from assigning it to verbal communication rather than meaning communication, or even from assuming that in any meaning communication, there has to be a verbal interaction. ‘Confused dialogic’ comes also from the versatile interpretation within ‘Dialogism’ described by Linell (2003) as “not one coherent school, or theory, not even anything that “dialogists” of different extractions would agree upon” (p. 1). Most critically, in my opinion though, ‘confused dialogic’ comes from an unclear approach of the ‘dialogic’ meaning at the level of utilisation on two planes: a) *the theoretical-empirical plane*, and b) *the educational context levels plane*.

The meaning adopted theoretically can be different from the interpretation operated empirically, and yet dialogic remains open to the two, and the two are embodied in each other to some degree (this issue is followed in more detail through Chapter 9). The inadequacy in revealing, or failing to realise, the concerned studies position in regard to the adopted theoretical and operationalised meanings is a source of ‘confused dialogic’. This is, in fact, the second encounter of this study with the theoretical-empirical duality (refer to section 2.1.3).

Secondly, utilised meanings of ‘dialogic’ differ between the educational context levels that ‘dialogic’ is assigned to, whether CT level, teaching one, or at the level of education more generally. In other words, between dialogic talk, dialogic teaching and dialogic education, dialogic would have relatively different meanings, although interrelated. One can anticipate, for example, that more philosophical theory would be found in approaching the meaning of dialogic education, but less is expected to shape the meaning of dialogic teaching, and the least to define dialogic CT. For example, while Wegerif’s (2007) interpretation of dialogic as an end in itself is most likely to be needed in theorising dialogic education, the simple meaning of dialogic as describing being in a dialogue with reference to the teacher’s authority, is most likely to define dialogic CT, and yet this meaning is embedded as part of that broader ontological interpretation. Again, the inadequacy in emphasising, or failing to recognise, the educational level that the concerned studies are assigning ‘dialogic’ to, is a source of ‘confused dialogic’.

In this sense, Dialogicity of CT would acquire different meanings between different contexts in approaching 'dialogic'. To have a clearer glimpse of this, let us think of Dialogicity as a scale, hence:

- if we take 'dialogic' as oral communication with another, then the Dialogicity of what is described usually as monologue, necessarily = 0, whereas the Dialogicity value of any exchanged verbal discourse can never be equal to zero;
- if we take 'dialogic' as an exchange of meanings (i.e. pertaining to dialogue), then the Dialogicity of the talk, in which there is no exchange of ideas = 0 (whether monologue or exchanged verbal discourse). Hence, the Dialogicity of monologue is not necessarily = 0;
- if we take 'dialogic' from the epistemological paradigm perspective, then the Dialogicity of any type of talk can never be zero.

This means that CT Dialogicity as a descriptive conceptualisation of the nature of the talk characterised as dialogic or not, is to be defined by the meanings associated to 'dialogic', and which needs to be declared by concerned studies. It is quite clear that this study is approaching dialogic at the level of CT. Therefore, the attention goes to following CT Dialogicity along the theoretical-empirical plane.

I shall not attempt through the following subsection- of reviewing relevant studies from language and science education, to prove the sources of 'confused dialogic', for the theoretical argument over this point is intended only to emphasise the need to rearrange our thoughts about 'dialogic' in terms of the levels within the two planes, and the need to declare these thoughts. Nevertheless, the subsection reviews the literature on dialogic talk and dialogic teaching and sheds light on the absence of a clear distinction between the two in the concerned studies, for the sake of justifying the study's adopted empirical approach in following CT Dialogicity afterwards. The main findings from these studies are also outlined to identify the major features of CT Dialogicity in its relation to the practice of teaching and learning, as suggested by research.

2.2.2 'Dialogic' in practice

In approaching the nature of interaction in classrooms in different studies, the word 'dialogic' has been used to label episodes of talk as well as to describe the dynamics of instruction, and the approaches to education more generally. Less literature can be found on dialogic education and much more on both dialogic CT and dialogic approaches to teaching. In many cases, defining dialogic talk or dialogic approaches to teaching was to be assigned to a certain meaning and contrasted to an opposite one within a duality of dialogic as opposite to monologic (Nystrand et al., 2001), or dialogic in contrast to authoritative (e.g.

Mortimer & Scott, 2003; Scott, Mortimer, & Aguiar, 2006), for example. Most frequently in the concerned studies, however, there is no obvious distinction between the two. The approaches to teaching would be described as dialogic or not along with the portrayal of Dialogicity of different events of talk throughout this teaching.

From a sociolinguistic perspective, Skidmore (2000) adopted Bakhtin's (1981) distinction between 'authoritative discourse' and 'internally persuasive discourse', as characterising two types of discourse based on the features of discourse as open or not-open to debate. Authoritative discourse, as not-open to debate, carries one definite meaning which cannot be changed, whereas internally persuasive discourse is opened to different and new meanings. By investigating the quality of teacher-pupil talk in guided reading sessions, Skidmore (2004) stated that his analysis shows that the observed sessions tend to authoritative discourse more closely than internally persuasive, suggesting that time should be allocated for students to explore their own understanding of what they have read and to formulate this understanding in their own words. Drawing on Bakhtinian ideas, as well, Nystrand (1997) and Nystrand et al (2001) differentiated between monologic and dialogic discourse. They view classroom discourse as monologic "to the extent that the main speaker, typically the teacher, operates from a pre-determined "script" and "dialogic" to the extent that the participants expand or modify the contributions of the others as one voice "refracts" another" (Nystrand et al., 2001, p. 2). Nystrand and Gamoran (1991) found that 85% of the American classes they observed were dominated by a combination of pre-planned, recitation, and seatwork discourse. Moreover, Nystrand et al (2001) used data in 872 observations of more than 200 eighth- and ninth-grade english and social studies classes in a variety of schools in the Midwest of America to investigate the classroom discourse. They found, again, that 'dialogic spells' are infrequent, affirming that classroom instruction is best thought of in terms of what teacher and students do, rather than what teachers do. Based on their findings along with Nystrand and Gamoran's (1991) results, they claimed that within the classroom, monologic discourse dominates and constitutes a force that "exerts considerable 'inertia', and tends to continue in direction and character unless someone, invariably, the teacher, counteracts this force" (p. 6). They extended their claim by focusing on the important role of the teacher in motivating their classes towards dialogic modes and the need for skill and insistence to do so.

Recently, Skidmore (2006) has reviewed the existing literature on the relationship between pedagogy and dialogue, which draws on the theoretical ideas of Bakhtin on the dialogic nature of language and Vygotsky's work on the relation between language and thought in sociocultural contexts. He chose three categories of dialogic discourse to represent the main contributions of literature in this respect. I shall borrow this categorisation to highlight some

of the key issues in these contributions using the main studies in which these categories have been presented and elaborated. These include: dialogic instruction (Nystrand, 1997; Nystrand et al., 2001), dialogic inquiry (Wells, 1989, 2000), and dialogic teaching (Alexander, 2000, 2004).

Dialogic instruction: in ‘Opening dialogue’, Nystrand (1997), researching (within a research group) the classroom discourse in English lessons in US high schools, described dialogic instruction as involving several voices of teacher and students in modifying or expanding the taught topic. This is in contrast to monologic instruction, in which the discourse is controlled by the teacher to transmit a fixed knowledge. In fact, he attempted to characterise the two types of instruction by comparing the two in regard to different key features.

Features	Monologically-Organised Instruction	Dialogically-Organised Instruction
Paradigm	<i>Recitation</i>	<i>Discussion</i>
Communication model	<i>Transmission of knowledge</i>	<i>Transformation of understanding</i>
Epistemology	<i>Objectivism: knowledge is a given</i>	<i>Dialogism: knowledge emerges from interactions of voices</i>
Source of valued knowledge	<i>Teacher, textbook authorities: excludes students</i>	<i>Includes students’ interpretations and personal experience</i>
Texture	<i>Choppy</i>	<i>Coherent</i>

Table 2.1: Comparison of Monologically/Dialogically Organised instruction (p.19)

As table 2.1 shows, the comparison has not included, explicitly, the interactivity feature. Rather, the communication aspect has been described in terms of transmission vs. transformation of knowledge. This implies that interaction is viewed in relation to the act of providing knowledge in the context of teaching, rather than simply exchanging turns of talk. Nystrand (1997), in fact, has portrayed the relationship between interaction in dialogic instruction and learning, stating that:

“The underlying epistemology of classroom interaction defines the bottom line of learning: What ultimately counts is the extent to which instruction requires students to think, not just report someone else’s thinking” (p. 72)

Based on the results of written examinations specifically, and surveys, interviews, and class observations generally, he also indicated the superiority of dialogically-organised over monologically-organised instruction in promoting student learning, although results show that the classroom discourse is “overwhelmingly monologic” (p. 41). However, he noted that some results have, actually, revealed the effectiveness of the monologic discourse of recitation that depends on whether and how teachers can expand the IRE sequence in their

instruction. Accordingly, he argued that in spite of the important role of topic-relevant, authentic questions in supporting dialogic discourse, the quality of the instruction that encircles these questions, is what, essentially, generates dialogic instruction.

Dialogic inquiry: in 'Dialogic inquiry' (1999) and 'Vygotskian perspectives on literacy research' (2000), Gordon Wells formulated the concept of dialogic inquiry, drawing on Vygotskian ideas of the relation between language and thought, Leont'ev's activity theory and Halliday's systematic functional linguistics. He used Vygotsky's concept of artifact-mediated joint activity to conceptualise the classroom as a collaborative community of inquiry, where participants are working together towards shared goals. He described inquiry in classrooms as a:

“stance that pervades all aspects of the life of a classroom community that is based on the social constructivist belief that understanding is constructed in the process of people working together to solve the problems that arise in the course of shared activity” (Wells, 2000, p. 12)

Part of his interest was directed to elaborate the dialogic building in the community of inquiry by examining transcribed classroom discourse in Canadian primary school classes. He described the discussion undertaken in the classrooms as a 'progressive discourse' in which students are allowed to refine and work on their ideas to generate a new understanding. This means that in dialogic inquiry, students can contribute to the progress of a community understanding of the topic in question. Based on this view, he built a model to characterise an enquiry-oriented curriculum, in which the teacher starts with choosing a class theme (e.g. force). Within this broad theme, students can negotiate with the teacher to choose specific topics and methods of inquiry, in a relation described by him as dialogic. In his description of the pattern of interaction in dialogic inquiry, Wells (1999) re-evaluated the I-R-F sequence, arguing that the follow-up move (F) can be used by the teacher to explain, exemplify, modify, expand or justify students' responses or to encourage them to do this (see more on this in section 9.1.4). This in turn can help students in evaluating the performed tasks or planning ahead for a coming task within inquiry teaching and learning.

Dialogic teaching: in *Culture and Pedagogy*, Alexander (2000) presents the findings of a large-scale comparative study of primary education in England, France, India, Russia and the United States, using data gathered in those countries during 1994-8. Part of the interest was to study and compare the pedagogy of teaching in the five countries by analysing the classroom experiences, interactions and discourses, using 17 samples of primary CT from different schools in the various countries. The representative extracts of teacher-pupil and pupil-pupil talk were analysed along the dimensions of: organisational frame (whole class, group, individual); interaction mode (direct instruction, discussion, monitoring); pedagogic function (rote learning, instruction, scaffolding, assessment, information sharing, problem

solving, supervision); and discourse form (interrogatory, expository, evaluative, dialogic). From the analysis, Alexander described the kinds of talk of direct instruction, discussion or monitoring along with their pedagogic function and discourse form within the different types of classroom organisation. Some results confirmed a finding from previous research that relates to the domination of the interrogatory whole class direct instruction. Other data, however, showed different ways of fostering pupils' learning through CT. He, accordingly, argued that "within the traditional bipolar distinction between 'transmission' and 'discovery' approaches (telling children as opposed to encouraging them to find out for themselves)" (p. 526), there is a continuum of several ways. One of the ways along the line is scaffolded dialogue, depicted by him as:

"Achieving common understanding through structured and sequenced questioning, and through 'joint activity and shared conceptions', which guide, prompt, reduce choices and expedite 'handover' of concepts and principles" (p. 527)

This concept of scaffolded dialogue has been then developed by Alexander (2004) by consigning it to the model of 'dialogic teaching', which is described by him as: "collective; reciprocal; supportive; cumulative; and purposeful" (p. 29). He also set a list of two-cluster indicators that can identify dialogic teaching in the classroom. The first cluster (including 14 indicators) refers to contextual conditions, while the other one (including 47 indicators) refers to characteristics of classroom discourse and interaction. However, Alexander (2000) highlighted the danger of underestimating the traditional ways of teaching (e.g., recitation and exposition) as opposed to the most recent dialogic teaching approaches of discussion and scaffolded dialogue, for example, based on the important role of the former in teaching, and the demanding nature of the latter in relation to teacher skill and pupils' effort. Moreover, he noted that in all the observed lessons in the five countries, teachers were asking questions. However, while in some lessons the question-response series follow "meaningful and cognitively demanding sequences", in others "such progress is either blocked by the recitative IR exchanges of rote, or, at the other extreme, questioning is random and responses are immediate and off the cuff rather than considered" (p. 520-521).

In summary then, in Wells' and Alexander's analyses, approaches to teaching would be defined as dialogic, as long as there is a kind of discourse that reflects the conventional meaning of a dialogue in general. Wells (1999) talked about dialogic inquiry, where students can work on their ideas to generate a new understanding by going through 'progressive discourse' within a collaborative community of inquiry. In this sense, Wells restricted dialogic to the teaching paradigm of inquiry. This can be seen as whether dialogic is acquiring its meaning from inquiry, or that inquiry is the most likely paradigm to reflect a dialogic approach to teaching. In both, dialogue loses its broadness of existence without

losing, however, some variety of its characteristics that Wells highlighted through different details of discourse type, interaction and patterns for example. Likewise, Alexander (2004) assigned the concept of 'scaffolded dialogue' to his model of dialogic teaching. In the last edition of his book on dialogic teaching, Alexander (2008c) described both discussion and scaffolded dialogue as the kinds of teaching talk having the greatest cognitive potential and likely to "meet the criteria of dialogic teaching" (p. 31). For Nystrand, describing approaches to teaching as dialogic would follow, simply, the frequency of talk that has been categorised as dialogic according to some methodological scheme. Consequently, for those events of talk classified as dialogic, the instruction would be described as dialogically-organised and vice versa.

Despite the peculiarities of the three approaches to dialogic theorising and the occasional different positions of focus, they actually hold a similar picture, agreeing over the main characteristics of dialogue. They look, for example, at the dialogic relation as to engage teacher and students, dialogic construction of knowledge as to consign together the participants' experiences, and dialogic interaction as to define a powerful and efficient approach to teaching and learning. They also agree, based on empirical findings, over the under-representation of dialogic talking in science and English lessons and the role of teachers in promoting the I-R-F sequence to produce a dialogic interaction. On the other hand, Nystrand (1997), Nystrand et al (2001) and Alexander (2000; 2004), with their broader depiction of dialogic teaching/instruction than Wells' (1999; 2000) articulation, have both argued that monologic and traditional paradigms of teaching could, in some cases, achieve the desired learning outcomes. Part of their argument in this respect was directed towards showing the importance of these paradigms in some contexts and the danger of underestimating their role in teaching and learning. This argument reveals basically, in my opinion, the limitation of the dialogic/not-dialogic classification, or as Alexander (2008c) puts it, in a later version of his work on dialogic teaching; "reduce the act of the teaching to a choice between two basic approaches ... 'formal', 'traditional' or 'didactic', and 'informal', 'non-traditional', 'exploratory' or 'inquiry-based'". (p. 28) This classification implies that all of the teaching within a lesson or a group of lessons is taken as dialogic or not. By not making a distinction between dialogic teaching as a whole and dialogic talk as part of this teaching, the reader might assume that dialogic teaching has to consist of dialogic episodes of talk only, and cannot allow a space for monologic ... direct talk. On the one hand, such theorisation reflects a sceptic view in approaching the nature and quality of classroom interaction. On the other hand, it does not provide a solid methodological base for investigating the Dialogicity of CT specifically, and the Dialogicity of teaching in general.

2.2.3 CT Dialogicity and the Communicative Approach

One of the recent contributions to describing dialogic teaching based on characterising CT Dialogicity is the work of Scott et al (2006) that came as a later development in working with the communicative approach (CA) introduced by Mortimer and Scott (2003) as a tool to characterise CT. In this section, I explore this tool in more detail, trying to convey the study's justification for implementing it, and the justification of the need to develop a broader analytical framework based on this approach.

2.2.3.1 Dialogic talk / dialogic teaching distinction

The CA is based on detailing the authority of the teacher in guiding CT, between being a verbal authority in one dimension and an intellectual one in the other. The verbal authority is represented by interactive and non-interactive classes that identify the talk as being exchanged between teacher and students or dominated by the teacher only. According to the second dimension concerning the intellectual authority, there is a 'Dialogic' type of CT, in which the teacher listens to and interacts with different meanings derived from the pupils' interpretations and personal experiences. This is in contrast to the teacher taking account of one meaning only representing usually the school science view; the talk that constitutes the second type of 'Authoritative' talk⁵.

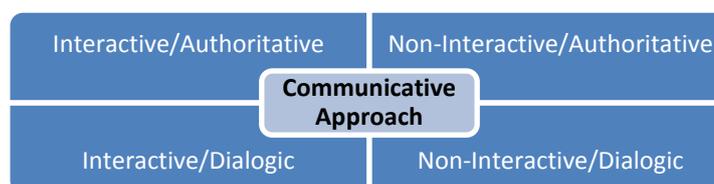


Figure 2.4: The four classes of talk in the CA

The interrelation between the two dimensions results in four classes that illustrate how the teacher works with students to develop the scientific view (fig. 2.4). When different opinions are explored and developed by the teacher and students together, then this constitutes the *Interactive/Dialogic* class. If the teacher and students, however, present and develop only the scientific view without paying attention to the students' interpretation, then this is an *Interactive/Authoritative* talk. Accordingly, the *Non-Interactive/Dialogic* class can be represented by the teacher alone reviewing the students' views, while in the *Non-Interactive/Authoritative* class, the teacher dominates the talk and draws the attention to the school science view only.

The CA can be seen as a step forward in providing a methodological tool that classifies CT into different types following a specified criterion (the authority of the teacher) in making a

⁵ Authoritative and Dialogic types of the CA are capitalised because they reflect a judgment of the nature of CT, using the CA as an analytical tool. However, when not capitalised, 'dialogic' and 'authoritative' refer mainly to adjectives describing the nature of CT.

judgment about the Dialogicity of CT. By detailing this criterion, the CA could broaden the view of dialogic talk by more specification of its meaning. On one hand, it breaks the bond between the Dialogicity of talk and the verbal interactivity; that for the talk to be Dialogic, it does not necessarily need to be exchanged between teacher and students. The talk can be dominated verbally by the teacher, but yet be Dialogic. Likewise, students can be participating in answering the teacher's questions, and yet this talk is to be considered Authoritative. On the other hand, it puts the authoritative and dialogic approaches together in one dimension, which allows the possibility of the talk to be Authoritative or to be Dialogic within a certain episode. In fact, this has led eventually to the flexible view to dialogic teaching, presented by Scott et al (2006).

Different case studies of teaching sequences that had been probed and analysed by Mortimer and Scott (2003) and Scott et al (2006) illustrated a shift in using the four communicative classes. Scott et al (2006), focusing specifically on searching this shift, talked about a tension between the Dialogic/Authoritative and Interactive/Non-Interactive classes. They argued that the tension is "an inevitable part of teaching whose purpose is to support meaningful learning of scientific knowledge" (p. 605). Therefore, dialogic teaching should include a movement between the different classes of talk. This means that in dialogic teaching, there is no preference of one type of interaction over the other because each one can have a certain function in a certain context and for a certain purpose. Adopting such a view of dialogic teaching contributes to the literature on CT Dialogicity by bringing more stability to its meaning; firstly, by drawing a distinction between dialogic talk and dialogic teaching (section 2.2.1), and secondly by breaking the scepticism in visualising teaching to be all 'dialogic' or 'not dialogic' (section 2.2.2) (this issue of dialogic teaching is re-opened in section 9.1.3).

2.2.3.2 Working with the Authoritative/Dialogic characterisation

In working with characterising CT, Mortimer and Scott (2003) related the communicative classes of talk to four other aspects concerning the teaching context; teaching purposes, content, pattern of discourse and teacher intervention. The five linked aspects are actually built over three groups of teaching focus, approach and action (table 2.2). Different science lessons from England and Brazil were analysed by Mortimer and Scott (2003) using their model as a research tool. The lessons were selected, particularly, for teachers who aspire to engage their students in interactive patterns to explore their everyday experiences leading to developing the school science view. The lesson sequences were divided into smaller episodes based on the class of the CA followed by the teacher and students. The other aspects concerning the focus and the action of the lessons were then utilised to provide a detailed account of the episode; the purposes served, the nature of knowledge discussed, the patterns of

discourse developed in and the kind of intervention performed by the teacher. Such detailed accounts of the different episodes had indeed characterised more specifically the classes of the CA as each episode is related to a certain class.

Teaching Group	Aspects of Analysis	
* Focus	1 Teaching purposes	2 Content
* Approach	3 Communicative approach (Interactive/Dialogic) – (Interactive/Authoritative) (Non-Interactive/Dialogic) – (Non- Interactive/Authoritative)	
* Action	4 Patterns of discourse	5 Teacher intervention

Table 2.2: The analytical framework of Mortimer and Scott (2003)

In part of this characterisation, Mortimer and Scott (2003) argued that there is a link between the I-R-F-R-F- chains of interaction and the dialogic approach to teaching when it is verbally interactive between teacher and students. This is in contrast to the Interactive/Authoritative kind of interaction that teachers tend to use while working only on the scientific view with the I-R-E- pattern of discourse. It has been also argued that the Interactive/Dialogic approach in the observed lessons is related to the purpose of exploring the students' ideas where the teacher had identified everyday ideas before moving to the scientific one. The Dialogic approach has also been recognised in relation to the teaching purposes of probing the students' understanding and guiding them to applying the scientific insight. 'Dialogic' has been assigned to these purposes because Mortimer and Scott (2003) have restricted its use to being an "opposing tendency to authoritative" in which the teacher is drawing the students' attention only to one meaning (p. 122). In general, they have identified six teaching purposes based on their observations of science classes and influenced by the theoretical perspectives provided by the sociocultural theory. These are:

- Opening up the problem;
- Exploring and working on students' views;
- Introducing and developing the scientific story;
- Guiding students to work with scientific ideas and supporting internalisation;
- Guiding students to apply, and expand on the use of, the scientific view, and handing over responsibility for its use;
- Maintaining the development of the scientific story

Probing these purposes reveals the Vygotskian perspective of the development of spontaneous concepts as to "proceed upwards" (Vygotsky, 1986, p. 193). Where do the spontaneous concepts proceed upward to? They simply proceed towards the scientific concepts. Through their book, Mortimer and Scott (2003) were concerned with the development of the scientific story in science classes. They built their framework based on their observations of teachers for whom their teaching performances were starting with the

students' spontaneous concepts proceeding upward to the scientific point of view. And so, they developed the teaching purposes that align with this line of progression from spontaneous to scientific concepts. Along this line, dialogic interaction has been recognised whenever the teacher pays attention to the students' points of views in relation to the ideas being developed in the lesson sequences. However, in studying the relation between spontaneous and scientific concepts, Vygotsky (1986) talked about the development of the scientific concepts as to go in a reverse direction to the spontaneous ones. As the spontaneous concepts develop upwards, the scientific concepts proceed in their development downwards. In their development towards the scientific view, spontaneous conceptions are actually moving from the unconscious to the conscious plane. By being explored, worked on and evaluated, they are, in fact, moving towards a more systematic and clear picture in the mind of the individual. On the contrary, the scientific concepts are born by school teaching on the conscious plane, but they are usually distant from the daily experiences of individuals. So in their development towards everyday ideas, they are actually moving towards a more concrete and practical picture (fig. 2.5).

Building on this relation, it is worth examining the development of the scientific story in science lessons in the opposite way to the upward path. It often happens that teachers of science begin with presenting the scientific account of a certain problem or phenomenon. In their attempt to explain and simplify this account, they have to explore, work on and evaluate the detailed aspects of the scientific story which might be exemplified by or compared to everyday experiences. It can be expected, therefore, that the line of progression downward from scientific to everyday views will reflect also a dialogic approach in the sequence of teaching (fig. 2.5).

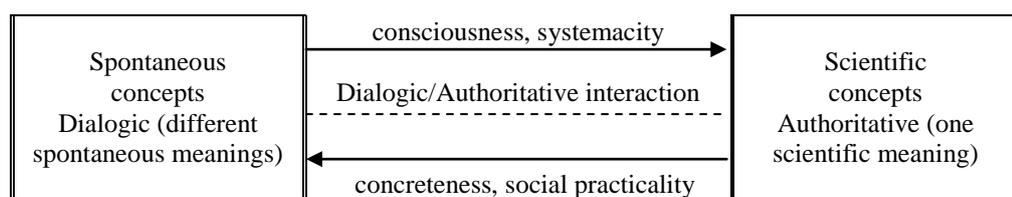


Figure 2.5: Dialogic/Authoritative interaction in Spontaneous/Scientific relation

But then, will the Dialogicity of the talk be the same along these two lines of development? In other words, following the specifications of the CA, different kinds of interaction, within the Authoritative and Dialogic classification, are expected to appear. The CA does not seem to address these differences or the interrelation that might happen between them. Moreover, it is most likely to have this linear continuity between spontaneous and scientific thinking regarding concepts like energy, force and rust, for example, as they have an evident everyday existence. It would be, therefore, most obvious how to develop along the intellectual line by shifting between the Dialogic/Authoritative communicative classes in dialogic teaching.

However, for scientific concepts that are primarily introduced to students in school science like chemical change, electromagnetic induction and isotopes, for example, it becomes trickier to recognise this line of development.

The representation in fig. 2.5, can be seen as to be limiting the Authoritative/Dialogic characterisation. For example, such characterisation restricts the teacher's focus on the scientific meaning to be Authoritative. But then, *what about the teacher listening to the students' analysis of the scientific meaning? What about the teacher interacting with the students' difficulties in understanding the scientific account?* Students start a lesson with a certain structure of knowledge regarding the taught scientific topic, and through the lesson sequence this early level changes from one stage to another. At each stage, therefore, there is an existing knowledge that needs to be developed (fig. 2.6), which is more likely to reflect a mixture of personal interpretation and scientific meanings.

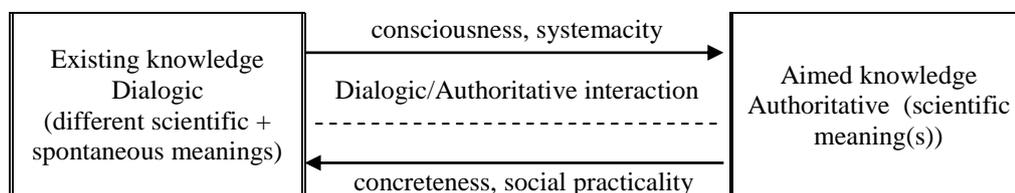


Figure 2.6: Dialogic/Authoritative Interaction in Existing/Aimed knowledge relation

As I argue that the representation in fig. 2.6 reflects a more substantial picture of how the teaching practice might proceed in guiding the CT, I realise, meanwhile, that it draws a more complicated picture of CT Dialogicity. Along with the divergences of the existing knowledge of the students, its variation from one stage to another, and the students' differentiation in the aimed knowledge they can reach, it is expected to become more difficult to distinguish between Authoritative and Dialogic features. These features within each type are expected, themselves, to vary from one episode of talk to another. Again, the CA alone does not seem to be able to address these differences (this issue is followed in section 9.1, specifically, 9.1.1).

In conclusion, It is suggested that a broader, and yet deeper analytical framework needs to be developed to characterise CT Dialogicity by analysing in greater depth the Authoritative and Dialogic types of talk defined by the CA. To develop such a framework, there is the need to identify the study's approach to discourse analysis; and this is what the next section is about.

2.2.4 Summary

- The first section of this part explored how ‘dialogic’ has been defined, establishing that various meanings can be found in literature. It has been argued, however, that ‘dialogic’ is confused in literature because of an unclear approach to its meaning at the level of two planes; the theoretical-empirical plane, and the educational level plane.
- The second section explored how ‘dialogic’ has been approached and investigated in both science and language education. It has been argued that no obvious distinction between dialogic talk and dialogic teaching can be found in the concerned studies. Evidently in research, both have been approached along the dialogic/not dialogic dichotomy.
- Determined by the argument in the first two sections, it has been ascertained that the study needs to declare how ‘dialogic’ CT is approached at the theoretical and empirical levels. Accordingly, the CA was explored in the third section to justify its implementation in this study as an empirical tool to characterise CT Dialogicity. Deeper discussion of its features and use raised the need to develop a broader, and yet detailed analytical framework to further characterise its Authoritative and Dialogic communicative approaches.

To this end, the CA within an analytical framework to be developed is decided to be implemented to follow CT Dialogicity at the empirical level; the use that will be evident in the analysis chapters (Ch. 6, 7, 8 & appendix 2). Reflection on this implementation in addition to approaching CT Dialogicity at the theoretical level is continued in Chapter 9.

In the next part, attention is directed to the approaches of discourse analysis to identify some bases that are to guide the development of the analytical framework.

2.3 Part 3: Approaches to discourse and discourse analysis

This part continues the task of focusing on CT Dialogicity by exploring the approaches to perceiving discourse as well as exploring the approaches of discourse analysis. As mentioned, this study aims to design an analytical framework to characterise in more detail the Authoritative and Dialogic classes of the CA. This part reviews different approaches to classroom discourse analysis, to identify at the end of it a number of bases to guide the development of the planned framework.

2.3.1 Laying a foundation

Whether we define discourse just in relation to the 'language in-use' or to be more explicit in relating the 'language-in use' to its social context (see Kelly, 2007), different approaches to discourse analysis can be identified. There is no 'uniquely right' approach, but for different issues and questions, certain approaches might fit better or worse than others (Gee, 2005). The different approaches due to different issues and questions can be viewed in the literature as to cluster in larger groups of different spots of focus. To help shape the boundary of the substantive review and for the interest of this study that is related to CT area, I shall review only the studies in the educational area which focus primarily on spoken discourse in classrooms from general sociolinguistic and sociological perspectives of analysis, excluding specifically the purely linguistic ones (those which focus on the linguistic structure and properties of talk and text). This is to get insight of the methodological potentials of the different approaches to analysis that might be useful in specifying the bases of the framework to be developed.

The first task is to identify the approach to perceiving discourse. The aim of this framework to be utilised in characterising the Dialogicity of talk, suggests the adoption of a dialogic approach to discourse in perceiving CT. This argument can be extended in fact, that for any study on discourse analysis, a dialogic approach to discourse is needed based on the Bakhtinian/Dialogism's view that any utterance - ultimately any discourse - cannot be but dialogic, and hence the meaning of utterance is dialogically constituted (Linell, 2003). The dialogical social cognitive approach to language and mind is described by Wold (1992) as representing:

"one important alternative to mainstream models within linguistics, psycholinguistics, cognitive psychology and cognitive science. These models, says Rommetveit ... "monologically based and covered in an image of Man as an essentially asocial, but highly complex information-processing device". Mainstream models have focused on structural and static description of language, trying to capture what language "is". Their conceptions of linguistic meaning have focused on "Grundbedeutung" in one way or another, searching for fixed components of meaning, literal or propositional meaning, all presupposing some kind of conceptual realities. (p. 2)

What is of great interest to this study, and which this dialogical approach advocates strongly, is the 'dynamic and open view to linguistic meaning' (Volosinov, 1986). In stating the essentials of this approach by Rommetveit (1992) through his 24 theses, the perception of the meaning of utterance as open and dynamic is reflected by the features of intersubjectivity and perspective taking, as the following theses state, for example:

(15) ... mutual understanding on the part of the conversation partners contingent upon reciprocally adjusted perspective setting and perspective taking

(16) Reciprocal adjustment of perspectives is achieved by an "attunement to the attunement of the other" by which states of affairs are brought into joint focus of attention, made sense of, and talked about from a position temporarily adopted by both participants in the communication.

(19) What is made known and claimed to be true about our "external" world by an assertive utterance at a given stage of a dialogue (its "propositional content") is contingent upon the dialogically established shared social reality at that stage.

(20) In order to find out whether a dialogically embedded assertion about some state of affairs is true or false we must therefore identify the intersubjectivity endorsed position from which that state of affairs is made sense of and brought into language. (p. 23)

Perceiving discourse in light of these features of intersubjectivity and perspective taking - among others within the dialogical approach (see Luckmann, 1992; Markova, 1992; Rommetveit, 1992) - points to the meaning potentiality in relation to the context in which the discourse is taking place; the context that can be "other words, extralinguistic information, or specific role relationships between participants" (Wold, 1992, p. 6). In fact, the Bakhtinian view of the utterance, as Todorov (1984) puts it: "the product of working up, in which linguistic matter is but one of the ingredients; another is all that is brought to a verbal production by the fact of it being uttered, that is its unique historical, social, cultural, context" (p. 26); such a view, if adopted, signifies that in any discourse analysis, the meaning to be told will be highly determined by the context and how it is realised, that even for a repeated utterance, the meaning would not be ever the same; for it is another unique attempt of 'attunement to the attunement of the other'.

Judging the Dialogicity of the talk and characterising its features necessitates making sense of the meaning in light of its relevant realised context. What I suggest therefore is the need for an approach to discourse analysis, in which the meaning would be the specific object to be focused on, in the way that 'Language' is the "specific object of linguistics" (Bakhtin, 1963, p. 242 in Todorov, 1984, p. 25). For getting to how this is to be achieved practically, it would be useful now to examine the potentials of different approaches to spoken discourse analysis in line of their historical development.

2.3.2 A selective review of discourse analysis approaches: A historical line

It might be more straightforward to define the spoken discourse in classrooms by the teacher-student or student-student verbal utterance, but it is less likely to agree upon a specific identification for what we mean by educational studies with a sociolinguistic or sociological perspective of analysis. In deciding about the educational studies on spoken discourse, I shall borrow Edwards and Mercer's (1987) articulation of the educational approach, under which they consider only the studies that relate directly to curriculum and pedagogy, although they are aware that "any research which looks at classroom communication might be described as 'educational' "(p. 24). I shall also rely on Edwards and Furlong's (1978) articulation of sociolinguistic and sociological approaches. In the sociolinguistic perspective that focuses on the forms and functions of language, "language is studied to see how it is organized to serve certain social purposes, and social relationships are studied to see how they are 'realized' linguistically" (p. 45). The sociological perspective, concerned mainly with the functions of language in relation to the classroom context, overlaps with the sociolinguistic perspective in approach and interest, most important of which to this study is what Edwards and Furlong (1978) call: 'the situational embedding of meaning' (p. 53). This means that the review of the selected educational studies will give more emphasis to the insights from sociolinguistic and sociological research regarding the function of spoken language in classrooms in the process of making meanings, in relation to the social, cultural and situational factors.

Certainly, this review aims neither to display a comprehensive account of all the studies in the specified fields, nor looks to present the fine details of their theoretical positions, methodological orientations and findings. Its structure follows a historical sequence to display some of the influential studies of CT in the educational area generally. This will include the period of time from the 1930s up until recently. Despite the huge data collected from multidisciplinary areas of research conducted in schools over years, Edwards and Mercer (1987) and Christie (2002) argue that by the end of the 1960s, little of this research had been interested in the observation and analysis of CT, but since the early 1970s, a growing body of studies in classroom discourse has been undertaken in the English-speaking world. The limited research in the period of the 1960s and before can be argued, however, to show integrated lines of theoretical and methodological orientations specifying the discourse analysis approaches. It followed, in fact, what Edwards and Mercer (1987) referred to as systematic observation, as opposed to the insightful observation implemented in their study of investigating CT. Some of these studies will constitute therefore the starting point in this historical review of CT studies.

2.3.2.1 The 1960s and before

In 1967, Amidon and Hough edited a book that embraces 29 selected papers that had been published between the 1930s and the mid-1960s about the theory, research and application of interaction analysis. They explained that their book is useful "for those interested in studying the dynamics of instruction and in applying the knowledge gained from their study to the training of teachers and the improvement of instruction" (Amidon & Hough, 1967, p. v). Eight of the selected papers in the book were published by Ned A. Flanders, one of the most prominent researchers in this area at that time. Flanders developed interaction analysis as a classroom observational technique out of social psychological theory, to test the effect of the social-emotional climate on pupils' attitudes and learning, where classroom climate refers to "generalized attitudes towards the teacher and the class that the pupils share in common in spite of individual differences" (Flanders, 1967b, p. 103). He described the interaction analysis technique as a:

"specialized research procedure that provides information about only a few of the many aspects of teaching. It is an analysis of spontaneous communication between individuals, and it is of no value if no one is talking, if one person talks continuously, or if one person reads from a book or a report ... Of the total complex called "teaching", interaction analysis applies only to the content-free characteristics of verbal communication" (Flanders, 1967a, pp. 218-219).

Going through the selected papers in this book reveals many details about the theory and practice that have shaped the studies of this period. I would like, however, to highlight briefly three general issues concerning the methodological approach and some findings. These are:

- Systematic observation of CT, using interaction analysis or similar techniques, has been used by different researchers to look into the quantity and quality of teacher-pupil interactions that have been considered as a critical dimension of effective classroom teaching (Amidon & Flanders, 1961; Amidon & Giammatteo, 1967; H. H. Anderson, 1939; Cogan, 1956; Flanders, 1967a, 1967b; Lewin, Lippitt, & White, 1939; Pankratz, 1967; Soar, 1965; Withall, 1949). The analysis involves the development and standardisation of some coding scheme that consists of a pre-defined set of categories. By assigning the observed interaction to these categories, the observer can then note the frequency of the qualitative acts. This means that the whole classroom interaction will be reduced to the defined categories, where their quantification results in a frequency distribution that can be drawn as a histogram profile covering short or long episodes of CT, to test defined hypotheses. This implies that this analytical approach depends heavily on the adequacy of the categorical scheme and the observer's skill to apply it during the time of observation.

- Using arithmetic calculations applying the numerical results of the aforementioned analysis (e.g. applying frequencies of categories in calculating: Direct-student talk ratio = categories 6,7,8,9/categories 10,11,12 (see Pankratz, 1967)), the researchers can then identify the quality of interaction. In studies following such procedures, the social-emotional climate has been conceptualised using different terms but with similar meanings (table 2.3); integrative/dominative (H. H. Anderson, 1939), democratic/authoritarian (Lewin et al., 1939), student-centred/teacher-centred (Withall, 1949), inclusive/preclusive (Cogan, 1956), and indirect/direct (Flanders, 1967b).

The integrative pattern	The dominative pattern
<i>a) Accepts, clarifies and supports the ideas and feelings of pupils b) Praises and encourages c) Asks questions to stimulate pupil participation in decision making d) Asks questions to orient pupils to schoolwork</i>	<i>a) Expresses or lectures about own ideas or knowledge b) Gives directions or orders c) Criticises or deprecates pupil behaviour with intent to change it d) Justifies his own position or authority</i>
Associated attitudes of teachers	Associated attitudes of teachers
<i>Outgoing, good-natured, friendly, cheerful, trustful, patient, self-effacing, self-submissive, responsive</i>	<i>Antisocial, surly, spiteful, dour, hostile, impatient, self-assertive, self-centred, aloof</i>

Table 2.3: Characterisation of social-emotional climate in Flanders (1967, p. 106)

It is remarkable that these meanings in describing approaches to teaching continue to be coloured in different places and different times with different terms, as we will see in what follows. What is more astonishing, however, is the persistence of the finding that dominative, authoritarian, teacher-centred, preclusive, direct (traditional, monologic, authoritative in successive studies) approaches dominate teaching practice, not through the times of these early studies only, but also through following years till today's earliest years of the 21st century.

- In addition to the finding above, some studies presented evidence to support the argument that the classroom climate can be objectively and reliably measured using the systematic observation clarified in the first point, where classification judgment and frequency estimations can be replicated by different observers (Amidon & Giammatteo, 1967; Pankratz, 1967). Other studies have also found that this climate is related to teaching effectiveness where pupils of teachers who use a teaching style that is both integrative and flexible have more positive attitudes towards school and their teacher, and achieve more than pupils of teachers who use a more dominative teaching style (Amidon & Flanders, 1961; Flanders, 1967a; Soar, 1965). The issue of this finding as to support the learning effectiveness of the integrative approaches has

been theoretically ascertained by many scholars over the years, but with much less support from empirical evidence.

It can be argued that the studies of this period are distinguished by two points of focus, as the two will start to grow less after this period. The first is the implementation of systematic observation as an approach in analysing classroom interaction. Although this approach has dominated studies in the sixties and before, very few studies in the time after have followed it (see ORACLE survey in Galton, Simon, & Croll, 1980 and STOS in Eggleston, 1983). Significant criticism has been actually levelled at this sort of analysis regarding their failure in providing deeper qualitative analysis of what is going on in the classroom:

"The kind of data obtained from systematic observation studies does not allow researchers to reconstruct the course of any given lesson; the only information available about the course of events after the lesson has finished is in the form of numerical frequency coding. One feels, therefore, that there was surprisingly little of the right kind of information available to researchers wishing to explain why teachers did one thing rather than another, or why certain patterns of classroom interaction seemed to work better in the teaching of some topics rather than others" (Edwards & Mercer, 1987, p. 25)

This criticism can be opposed by the argument that this approach might be more appropriate for certain purposes and for certain kinds of data intended to be gathered (see Eggleston, 1983 for more on this argument). Needless to mention the 'objectivity' and 'reliability' of this quantitative approach, for which qualitative approaches are usually criticised. However, the deficiencies of systematic observation, along with the development in audio recording facilities, led to the demise of this approach in favour of 'insightful observation' approaches that developed gradually over the years.

The second focus of studying classroom interaction that diminished after the 1970s is the investigation of the emotions and feelings of both teachers and pupils. Although most of the studies on classroom interaction have adopted a sociocultural position, it is rare to find studies which make the 'emotional climate' explicit in their discussion. Sutton (1992, p. 79) has re-emphasised the significance of examining the emotional climate in classroom interaction studies. He noted that the developing of thoughts and meanings in the classroom cannot be examined without paying attention to the social and emotional relationship established between teacher and pupils, stressing that language does not have a cognitive function only but an emotional one as well. This emotional function is important, in his opinion, in performing the 'persuading task' of teaching.

I move on now to show how the systematic analysis started to decline and give way to insightful observation in the 1970s' studies.

2.3.2.2 The 1970s

Attached to the words of 'discourse analysis', Sinclair and Coulthard (1975) analysed, from a sociolinguistic perspective, the structure of CT in secondary classes. Although their research purpose was not of educational concerns, their study has its educational application that justifies its presence in this review. In their model of CT analysis, they categorised CT under five hierarchical levels of 'lesson', 'transaction', 'exchange', 'move' and 'act'. The analysis was based, therefore, on organising the CT of a certain lesson into different transactions to be then classified into one or more exchanges, and so forth. A significant contribution, for which Sinclair and Coulthard are remembered, is their description of the moves in the 'I-R-F' exchange structure, which refers to an *initiation* by a teacher that elicits a *response* from a pupil, to be followed by a *feedback* from the teacher. As part of his ethnographic study that aims to look into the social organisation of classroom lessons, Mehan (1979) focused also on analysing the structure of the teacher-student interaction. He used the exchange structure of 'I-R-E' (where E refers to evaluation) to describe the turns of talk between the teacher and pupils, before using the frequency of the 'moves'; I, R or E to characterise the CT of the whole lesson.

These studies followed a systematic analysis of the classroom interaction, depending on defining categories and estimating frequencies. They are, however, less designed around the 'scientific mode of inquiry', starting from defining hypotheses and progressing by testing them to reach some findings, as those studies which adopt 'systematic observation'. Instead, these studies can be seen to start the movement from 'systematic observations' towards 'insightful observation'. They took a progressive step towards more insightful analysis when they started to direct the attention to the structure of the discourse itself. Their triadic coding of CT as initiation, response or follow-up, is difficult, if not impossible, to ignore in any analysis of any CT.

However, these studies could not survive the criticism from the supporters of the sociocultural tradition. The emphasis of these two studies on the forms of the discourse, as I, R or F, without giving a real concern to the meanings embodied in these forms, is what stimulated Edwards and Mercer (1987, p. 10) to describe this approach to analysis- using Stubbs' (1981, p. 128) words- as merely 'scratching the surface'. They argued that it deals "with the form of what is said rather than with its content" (p.10). In this respect, Christie (2002) wrote that:

"Ironically, a great deal of classroom discourse analysis has had a lot to say about the structuring of talk in terms of the IRE and related moves, but it has often neglected to look at the nature of the meanings in construction, the relative roles and responsibilities of teachers and students at the time of constructing those meanings, and the placement of such patterns in the overall larger cycle of classroom work" (p. 5)

In spite of this, the IRE/F pattern was to become the subject of interest of wide studies since Sinclair and Coulthard (1975) and Mehan (1979) introduced it. It has been used to criticise the teaching practices that restrict the participation of the students to the 'R' move in the pattern that is controlled by the 'I' and 'F' moves from the teacher. There was a call, consequently, for more exploratory patterns of talk in which the initiation and feedback from the teacher are to be more open and elaborative, and where the student can stimulate the talk by taking the turn of the initiation for example (Alexander, 2004; Driver et al., 1994; Lemke, 1990). Quite the reverse, there has been a call to look at the total patterns of talk in which the IRF/E exchange occurs, rather than merely rejecting it as reflecting a constraint to students' intellectual involvement in building a solid understanding (Wells, 1999, p. 169). Mehan (1979) did actually talk about an active role of students through the IRE pattern of talk in the primary lessons he observed and analysed. He considers, for example, that:

“effective participation in classroom lessons involves distinguishing between directive, informative, and elicitation speech acts and providing the proper replies (reactions, acknowledgments, and responses) on the right occasions in order to produce symmetry between initiation and reply acts” (p. 134-135).

In this quote, Mehan is talking about the 'effective participation' of pupils in terms of their ability to perform good verbal communication with the teacher, but not explicitly in terms of intellectual involvement. However, it is not surprising to find such articulation when we put into consideration Edwards and Furlong's claim in 1978 that classroom research documents teachers' dominance by "showing how much of the communicative work is normally done by them, and how restricted are the communicative roles normally available to students" (p. 18).

A remarkable contribution in developing research in classroom discourse from systematic to insightful analysis is the work of Douglas Barnes (e.g. Barnes, 1971, 1973, 1976). Based on his belief in the significant role of CT in learning, he attempted to explore the relationship between the features of CT and learning, and how they are influenced by the social context in which CT takes place. He did this by recording episodes of talk from various disciplines in secondary classes and making observational notes of events in these classes that might help him to understand the context. The advance in the recording facilities at that time enabled him to examine in detail the teacher-pupil talk, and the pupil-pupil talk in groups' discussions which constituted in later years a main focus in his studies (see Barnes & Todd, 1977, 1995). Barnes is prominent, in fact, in starting the tradition of transcribing the talk of lessons and using extracts of it as data to be analysed, interpreted and reflected on to reach some findings, where different features of CT are organised in larger scale analytical categories. Despite the criticism of lacking objectivity and reliability as "the approach seems

altogether too subjective, involving unsystematic 'interpretive leaps' from data to conclusion" (Edwards & Mercer, 1987, p. 28), this tradition of research has extended widely through classroom discourse studies.

As a result of this wide implementation and the emergence of cheap video recording devices, there has been a development in the research of CT to focus deeply on the content of the discourse. The study of Edwards and Mercer (1987), presented in the next subsection, represents a good example of such development.

2.3.2.3 The 1980s up to recently

Adopting a sociocultural perspective on human thought and understanding, Edwards and Mercer (1987) focused their study on looking into how what they call 'common knowledge' is constructed through joint activity and discourse. They have been interested, in doing this, in interpreting the people's meanings rather than coding their turns in speaking. They argued that the common knowledge built in the classroom constitutes, itself, a contextual basis for further communication. They elaborated this point, saying that:

"Overt messages, things actually said, are only a small part of the total communication. They are only the tips of icebergs, in which the great hidden mass beneath is essential to the nature of what is openly visible above the waterline. This is why context and continuity are essential considerations in the analysis of discourse" (p. 160).

They considered the development of common knowledge through CT as problematical because of different attributes, most important of which is the issue of 'control' over knowledge and learning between teacher and pupils. They argued that because of the teacher's control over what is done, said, and understood, education actually plays the function of "cognitive socialization" (p. 161). They talked about their surprise at the extent to which the teacher controls the mental and the physical activities in the classroom during the lessons that were characterised by the more progressive sorts of teaching. They argued, subsequently, that under teacher control, the process of education in 'pupil-centred' classes is of cognitive socialisation rather than of individual discovery. Based on an increasing level of teacher control, they identified the following features of classroom discourse: elicitation of students' contributions, significance markers, joint-knowledge markers, cued elicitation of students' responses, paraphrastic interpretations of students' contributions, reconstructive recaps, and direct lecturing. They considered, though, that "The extent to which educational knowledge is made 'common' through classroom discourse is one measure of the effectiveness of the educational process" (p. 161). In this respect, they distinguished between two kinds of educational knowledge; ritual knowledge ("essentially procedural, routinized, expedient" (p. 162)) and principled knowledge ("explanatory and reflective, which is not tied to specific courses of action" (p. 162)).

There are, in fact, different themes and issues that Edwards and Mercer have raised through their analysis of CT, utilising the 'insightful observation' approach. It is indeed due to its sensitivity to contextual factors and the increased opportunity it allows for in-depth exploration that this approach has continued to grow and direct CT studies. It has gained momentum, in my view, with the orientation of research towards sociocultural theory of learning and a qualitative approach to analysis. Today, the mainstream research on CT is taking on this approach, certainly within different theoretical and methodological trends. Hence, Edwards and Mercer's study is only one early glaring example of this mainstream research, for which I settle in describing the use of the insightful approach to analysing CT (more examples: Chin, 2006; Dawes, 2004; Driver et al., 2000; Lemke, 1990; Mercer, 1995, 2000; Mortimer & Scott, 2003; Nystrand, 1997; Scott & Ametller, 2007; Wells, 1999).

2.3.3 Summary: Pillars of the analytical framework

In light of insights gained from the reviewed literature concerning the position of CT in relation to teaching and learning and the views of learning, and within a dialogical approach to discourse analysis that is based on an open and dynamic view to meaning in relation to the context, the analytical framework in this study will be designed to:

- adopt sociocultural/sociolinguistic perspectives to discourse analysis by focusing on the forms, content and functions of spoken language in classrooms in the process of making meaning in relation to the context. This includes taken into consideration the social, cultural and situational factors, with a focus on the personal influence from an individual perspective;
- implement the advantages of both the systematic and the insightful approaches to discourse analysis by performing a qualitative analysis of the talk, focusing on its structure, content and context, and quantifying some of the qualitative acts;
- characterise CT Dialogicity by analysing in more detail the Authoritative and Dialogic types of talk as classified by the CA of Mortimer and Scott (2003);
- characterise CT in relation to what it can tell us about pupils' learning. That is, to design the framework to provide some information that can be used to follow how certain types of talk seem to support/not support pupils' learning.

The structure of this framework is presented in detail in the next chapter. In the next section, I present a refined version of the steps of research set out in the previous chapter (section 1.2).

2.4 Refined version of the main steps of this research

Given the purpose of the study presented in the previous chapter (section 1.2) of reflecting on and developing the concept of Dialogicity as a theoretical perspective to approach the nature of CT in relation to teaching and learning, and in light of insights gained from the reviewed literature, the study is planned to:

1. Characterise CT from the Dialogicity perspective, involving :
 - 1.1 develop an analytical framework to analyse CT following the defined approach to discourse analysis;
 - 1.2 classify recorded CT in Omani science classrooms into the CA classes of Mortimer and Scott (2003);
 - 1.3 characterise the Authoritative and Dialogic communicative approaches in more detail, using the developed analytical framework;
 - 1.4 reflect on results to discuss how CT Dialogicity can be approached at the theoretical and empirical levels, in view of existing relevant literature.
2. Investigate the relationship between CT Dialogicity and pupils' learning, involving steps to:
 - 2.1 look into indicators of pupils' learning resulting from the application of the analytical framework to the recorded CT;
 - 2.2 examine the pupils' conceptual understanding following the observed teaching;
 - 2.3 reflect on results to discuss how the pupils' learning is influenced by CT Dialogicity.

Furthermore, the persistent finding in the related research of a deficiency in dialogic practice in teaching (sections 2.1.1 and 2.2.2) suggests that it is less likely to find data on Dialogic talk as opposed to Authoritative type. It was decided, therefore, to conduct a short training intervention for the participating Omani teachers with the hope of maximising the chance to generate data of varying types of CT. In a second stage following the intervention therefore, the same participating Omani teachers and pupils are observed once again for the teaching of a different scientific topic, and the recorded CT is also analysed and scrutinised. Hence, the two planned aims are to be followed again using the data of the second stage. The research questions built on these two aims and their steps of research are presented at the beginning of the methodology chapter (section 5.1).

The next chapter follows aim 1.1 of developing an analytical framework to characterise the Authoritative and Dialogic communicative approaches.

3 CHAPTER 3: THE ANALYTICAL FRAMEWORK

This chapter describes the analytical framework developed to analyse CT. It begins by giving an overview of the framework before describing each of the four parts it consists of (section 3.1). To demonstrate how it works, examples of its application are presented (section 3.2).

3.1 Introducing the framework

This framework is designed for the purpose of characterising the talk exchanged between the teacher and pupils in science classes (whether initiated by the teacher or pupils), and guided by the four bases that have been drawn from relevant literature (refer to section 2.3, specifically 2.3.3):

- adopt sociocultural/sociolinguistic perspectives to discourse analysis;
- implement the advantages of both the systematic and the insightful approaches to discourse analysis by performing both qualitative and quantitative analysis;
- characterise Authoritative and Dialogic types of the CA in more detail;
- characterise CT to provide some insights on pupils' learning.

This framework draws upon ideas and contributions from a variety of resources. It is made up of four parts. The first two aim to analyse examples of the exchanged talk in fine detail regarding various facets related to the features of the talk itself, and the features of the context in which this talk is taking place as well. Whereas the third one is directed to look only for a quantitative representation of the quality of the utterance moves (I, R and F), the fourth part puts the details of the first three parts together through a narrative profile, in the attempt to reach some kind of general characteristics that might typify certain types of talk. In what follows, there is a description of the content and functions of each part⁶:

3.1.1 Part one: Analysing the talk

This part examines the talk in relation to six aspects, starting with the speaker and ending with remarks from the context of the teaching on one hand, and the context of the analysis (how and why to assign certain features to certain categories) on the other hand, as follows:

1.Speaker	2.Utterance	3.Move (I,R or F)	4.Initiation (Quality)	5.Response (Quality)	6.Follow-up (Type)	7.Contextual Remarks
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Table 3.1: Structure of the first part of the analytical framework

⁶ I realise that the reader might find difficulty in understanding some of the provided description. However, it is the case with any practical tool that its theoretical description cannot be understood in isolation from its application. Hence, I provide all the framework analysis in appendix 1, for the reader to see different examples.

Cells 1 & 2: each row in this table of analysis is specified by the speaker (Teacher or Pupil) and the utterance spoken by him/her in each turn.

Cell 3: the utterance is then categorised as an ‘Initiation’, ‘Response’ or ‘Follow-up’ moves. By examining these moves, there is the attempt to learn more about the teacher and pupils’ contributions in guiding the talk and colouring its different types. The theoretical bases and criteria of this categorisation are as follows:

- An **‘Initiation’ (I)** refers to a ‘Question’, which indicates, in turn, a cognitive and behavioural activity that gives a verbal direction from a first speaker to a second speaker, to use his/her memory or thinking to produce some response in examining an informative material. Under this conception, both the directive statements (e.g. There is a cave ... I guess some of you have visited it), and interrogative sentences (e.g. What have you seen in the cave?) are considered as questions. Any other instructional directions from a first speaker that do not require an overt response from the second speaker are not characterised as questions (Andre, 1979). On the other hand, not all the questions refer to initiations. Some of the questions uttered by either the teacher or the pupils are considered a type of follow-up move. Whenever a questioner asks a second question regarding and following the answer of a first question, then the first question is to be categorised as an initiation, where the second is to be considered as an elaborative follow-up (to be explained later on) and not an initiation.
- A **‘Response’ (R)** is the verbal or non-verbal reaction provided by either the pupil or the teacher to answer a certain question, whether this question is an initiation or an elaborative follow-up move. Any statement provided by a respondent that has not been uttered to answer the query of the questioner is not to be categorised as a response. Rather, it refers to a second type of follow-up move, named a ‘Comment’.
- A **‘Follow-up’ (F)** is the *utterance spoken by a second speaker* following and regarding specifically the response of a first speaker. In some rare incidents, it actually follows the first speaker’s initiation (I-F) (e.g. in talk initiated by pupils) but does not, in itself, provide a clear response to that initiation. Moreover, each turn can enclose two types of follow-ups (e.g. the teacher comments on a pupil’s answer and then elaborates it) which means that the follow-up move can be defined also as *an utterance spoken by the same speaker*, following and complementing his/her first, but of a different-type of follow-up. As a result of such articulation, confusion can sometimes happen between the characterisations of a certain utterance as a follow-up, an initiation, or even a response, but this can be more clearly explained when it comes to the types of follow-ups.

Cells 4 & 5: subsequent to the ‘Move’ step is the categorisation of the quality. Probing the talk in regard to this insightful facet is an attempt to investigate learning and to draw some of its outcomes, in addition to the main aim of this framework of characterising different types of talk. To measure the quality, there is the need to develop some form of quality coding to classify the quality level manifested in questions and responses. It was planned primarily that this quality is to be measured by a hierarchy of cognitive processes reflected by the wordings and meanings of the questions and responses. Investigating the cognitive processes is quite tricky and debatable, as we can neither observe the speaker’s thoughts nor can we trace the cognitive history behind those thoughts. However, it can be argued that thoughts, to an acceptable extent, are made visible through talk, and by analysing this talk, these thoughts can be revealed. What we actually do, in working with such a framework, is to infer the cognitive processes employed by the speaker from the words we hear, the accompanied actions we see and the contextual factors we get to know. Certainly a significant limitation can be set on our inferences.

A great deal of the research on classroom questioning has been focusing on this variable of cognitive level using several similar coding schemes (see examples in a review of the articles on classroom questioning presented by Kathleen Cotton, 1998). However, it is less frequent to find research on the cognitive level of responses. Within studies investigating the relation between the cognitive level of questions and different outcomes of students’ learning (e.g. Andre, 1979) few have focused on the cognitive level of responses (e.g. Dillon, 1982). In such studies, some researchers argue that the notion of ‘Ask a higher-level question, get a higher-level answer’ has always pre-assumed a cognitive correspondence between question and answer, which does not have, in reality, a dependable base in empirical research (Andre, 1979, p. 280; Cotton, 1998, p. 4; Dillon, 1982, p. 540). From another perspective, Carlsen (1991) argued that research on classroom questioning needs to shift from the theoretical orientation of ‘Process-Product’ in which a question is seen as a teacher behaviour, to a sociolinguistic orientation that perceives a question as a mutual construction between teachers and students. Similarly, Cotton (1998, p. 4) recommended that the effect of the cognitive level of questions needs to be investigated “in relation to the subject matter, the students, and the teachers’ intent” in order to reach some meaningful conclusions.

Aligning with such recommendations, the quality facet in this framework is to be characterised by examining the cognitive level of both questions and responses, relying on:

- their linguistic structure and meaning;
- their content of the subject matter;

- their context of teaching and social interaction.

Besides, early scrutiny of the data has helped me to develop other criteria that can support the inference of the cognitive processes by broadening the inclusiveness and operationality of the quality coding scheme. The framework adopts the criteria of ‘Divergence’, ‘Complexity’ and ‘Originality’ of the questions and responses in addition to their cognitive level (table 3.2). It is to be noted that these criteria are applied only when the inference of the cognitive level becomes difficult.

Criterion	Question	Response
1. Cognitive process	Remember / Understand / Apply / Analyse / Evaluate / Create	Remember / Understand / Apply / Analyse / Evaluate / Create
2. Divergence	Close-ended / Open-ended	
3. Complexity	Simple / Complex	Simple / Complex
4. Originality		Usual / Unusual

Table 3.2: Quality Coding scheme in the analytical framework

In coding the first criterion, the framework utilises ‘The Cognitive Process Dimension’ (fig 3.1); one of two dimensions included in the ‘Taxonomy of Learning, Teaching, and Assessing’ by Anderson et al. (2001). This modified taxonomy includes a ‘Knowledge’ dimension in addition to the ‘Cognitive’ one introduced in Bloom’s original taxonomy (Bloom, 1956).

The ‘Cognitive’ dimension- the interest of this framework, has been slightly modified in its sub-categories and in the sequence of the main categories. Compared to the original taxonomy, the modified ‘Cognitive’ dimension offers a more simplified but condensed and clear description of the categories. However, there is no genuine difference between the two, and the original one can find its place in this framework. Compared to alternative taxonomies (for such comparisons, see the work of Anderson et al (2001, pp. 262-263, 276-277), and Gall (1970, p. 709)), Bloom’s taxonomy seems to suit its function in this framework. In fact, it can be argued that these taxonomies have appeared to “supplement, clarify, and improve upon the original” (i.e. Bloom’s taxonomy) (Anderson et al., 2001, p. 259).

CATEGORIES & COGNITIVE PROCESSES	ALTERNATIVE NAMES	DEFINITIONS AND EXAMPLES
1. REMEMBER —Retrieve relevant knowledge from long-term memory		
1.1 RECOGNIZING	Identifying	Locating knowledge in long-term memory that is consistent with presented material (e.g., Recognize the dates of important events in U.S. history)
1.2 RECALLING	Retrieving	Retrieving relevant knowledge from long-term memory (e.g., Recall the dates of important events in U.S. history)
2. UNDERSTAND —Construct meaning from instructional messages, including oral, written, and graphic communication		
2.1 INTERPRETING	Clarifying, paraphrasing, representing, translating	Changing from one form of representation (e.g., numerical) to another (e.g., verbal) (e.g., Paraphrase important speeches and documents)
2.2 EXEMPLIFYING	Illustrating, instantiating	Finding a specific example or illustration of a concept or principle (e.g., Give examples of various artistic painting styles)
2.3 CLASSIFYING	Categorizing, subsuming	Determining that something belongs to a category (e.g., concept or principle) (e.g., Classify observed or described cases of mental disorders)
2.4 SUMMARIZING	Abstracting, generalizing	Abstracting a general theme or major point(s) (e.g., Write a short summary of the events portrayed on a videotape)
2.5 INFERRING	Concluding, extrapolating, interpolating, predicting	Drawing a logical conclusion from presented information (e.g., In learning a foreign language, infer grammatical principles from examples)
2.6 COMPARING	Contrasting, mapping, matching	Detecting correspondences between two ideas, objects, and the like (e.g., Compare historical events to contemporary situations)
2.7 EXPLAINING	Constructing models	Constructing a cause-and-effect model of a system (e.g., Explain the causes of important 18th-century events in France)
3. APPLY —Carry out or use a procedure in a given situation		
3.1 EXECUTING	Carrying out	Applying a procedure to a familiar task (e.g., Divide one whole number by another whole number, both with multiple digits)
3.2 IMPLEMENTING	Using	Applying a procedure to an unfamiliar task (e.g., Use Newton's Second Law in situations in which it is appropriate)
4. ANALYZE —Break material into its constituent parts and determine how the parts relate to one another and to an overall structure or purpose		
4.1 DIFFERENTIATING	Discriminating, distinguishing, focusing, selecting	Distinguishing relevant from irrelevant parts or important from unimportant parts of presented material (e.g., Distinguish between relevant and irrelevant numbers in a mathematical word problem)
4.2 ORGANIZING	Finding coherence, intergrating, outlining, parsing, structuring	Determining how elements fit or function within a structure (e.g., Structure evidence in a historical description into evidence for and against a particular historical explanation)
4.3 ATTRIBUTING	Deconstructing	Determine a point of view, bias, values, or intent underlying presented material (e.g., Determine the point of view of the author of an essay in terms of his or her political perspective)
5. EVALUATE —Make judgments based on criteria and standards		
5.1 CHECKING	Coordinating, detecting, monitoring, testing	Detecting inconsistencies or fallacies within a process or product; determining whether a process or product has internal consistency; detecting the effectiveness of a procedure as it is being implemented (e.g., Determine if a scientist's conclusions follow from observed data)
5.2 CRITIQUING	Judging	Detecting inconsistencies between a product and external criteria, determining whether a product has external consistency; detecting the appropriateness of a procedure for a given problem (e.g., Judge which of two methods is the best way to solve a given problem)
6. CREATE —Put elements together to form a coherent or functional whole; reorganize elements into a new pattern or structure		
6.1 GENERATING	Hypothesizing	Coming up with alternative hypotheses based on criteria (e.g., Generate hypotheses to account for an observed phenomenon)
6.2 PLANNING	Designing	Devising a procedure for accomplishing some task (e.g., Plan a research paper on a given historical topic)
6.3 PRODUCING	Constructing	Inventing a product (e.g., Build habitats for a specific purpose)

Figure 3.1: The Cognitive Process Dimension in Anderson et al. (2001)

According to this dimension, both questions and responses can be classified at one of the six levels; ‘Remember’...‘Create’ (fig.3.1). Their sub-categories provide a more detailed description that can help in inferring the cognitive processes. However, this categorisation is to be focused into a descendent hierarchy of only two elements; ‘Low’ and ‘High’. Adopting this simple hierarchy is a methodological obligation to describe the quality within the purpose for which it is basically introduced without going into unnecessary details. Literature shows that a low cognitive level is usually assigned to the process of remembering (Andre, 1979; Cotton, 1998; Gall, 1970). However, developing this framework along with scrutinising some of the data showed questions and responses that cannot be classified into the ‘remember’ category. Yet they do not indicate high cognitive processes as compared to the others that do (e.g. ‘simple electric circuit contains one device only’ as compared to ‘simple electric circuit contains less components’). Going through more examples and understanding them in view of their context led eventually to consider the lowest three sub-categories of the cognitive process of ‘Understand’ (refer to fig. 3.1) as more likely to describe low rather than high cognitive level. Figure 3.2 describes my interpretation of the cognitive processes’ classification under the low and high levels:

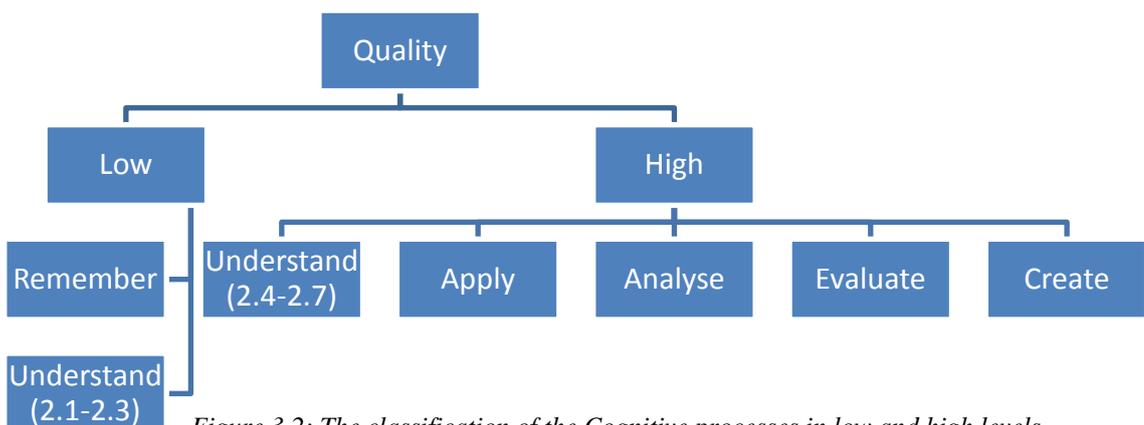


Figure 3.2: The classification of the Cognitive processes in low and high levels

Regarding the other three criteria, there follows a description of their meanings and anticipated contribution in determining the quality of questions and responses when the application of the cognitive dimension fails to do so (e.g. when respondents offer answers without explanation, that makes it almost impossible to agree upon one reliable judgment):

1- Divergence: has two categories for questions:

- Close-ended: a question that has (a) pre-specified answer(s). This type indicates that the questioner is interested in a specific thought or piece of information. It is more likely, therefore, to support the inference of low cognitive/quality level;
- Open-ended: a question that has no pre-specified answer(s) or allows a range of answers. This type indicates that the questioner is interested in what the respondent think about or knows. It is more likely therefore to support the inference of high cognitive/quality level.

2- Complexity: has two categories for both questions and responses:

- Simple: an utterance that embodies one issue/notion without an established relationship between its facts/elements. This type is more likely to support the inference of low cognitive/quality level;
- Complex: an utterance that embodies one issue/notion with established relationship between its facts/elements, or involves more than one issue/notion with an established relationship between them. This type is more likely to support the inference of high cognitive/quality level.

3- Originality: has two categories for responses:

- Usual: a response that shows a repeated, normal or expected thought about the posed question. This type is more likely to support the inference of low cognitive/quality level;
- Unusual: a response that shows original, unexpected or remarkable thought about the posed question. This type is more likely to support the inference of high cognitive/quality level.

Cell 6: to characterise the follow-up move (cell 6 in table 3.1), I chose a classification that specifies its type based on its function in the talk. This classification has been derived from relevant literature on the one hand, and has been guided by a methodological factor on the other. Methodologically, I was seeking a classification of the F move that fits with the hierarchical classification of the quality, where this hierarchy is needed to conduct the intended quantification of the kinds and functions of the moves.

Since introducing the triadic pattern I-R-F of talk, the third move (widely referred to as Evaluation, Feedback, and Follow-up) has captured a special interest in research as compared to the other two. Part of this research was directed to classifying the F move into different categories based on its function through the teacher-pupil interaction (e.g. Nassaji & Wells, 2000) and implementing it as a distinctive dynamic in portraying different types of CT (e.g. Mortimer & Machado, 2000; Mortimer & Scott, 2003; Scott, 1998). Mortimer and Machado (2000) used a simple classification that includes only two categories of evaluation and elaboration. Although the elaboration category can be classified into different subcategories, I believe that the two general categories of evaluation and elaboration—representing the two opposite extents that this move can take, offer a rational capacity to characterise its functions. This framework adopts this classification, but complements it with a neutral category of ‘Comment’, borrowed from the work of Chin (2006) on designing a ‘Question-based Discourse’ Analytical Framework.

Here is a detailed account of the three categories:

- **Evaluative follow-up (E_v)** is an utterance given by the teacher to provide positive or negative feedback for the pupils' answers. It can take the form of appraising, affirming, agreeing/disagreeing with, approving/disapproving responses. Because of its function in closing a sequence of talk, any question following it is to be always considered as an initiation. It is to be noted that this evaluative follow-up, in addition to the elaborative follow-up, can be conveyed sometimes by non-verbal language through the speaker's body language or tones of talk. This type is also distinctive from the other two types in the sense that it represents an exclusive contribution in favour of the teacher in any exchanged talk with pupils.
- **Elaborative follow-up (E_L)** is an utterance given by a second speaker to extend the response of a first speaker. It can take the form of eliciting, diagnosing, scaffolding, prompting, encouraging, challenging respondents' thinking and ideas. Sometimes, there can be a fine line between an utterance to be characterised as an initiation or an elaborative follow-up. Methodologically, the question posed by a second speaker in response to a first speaker's response is to be characterised as an elaborative F if it approaches the previous response from the same raised point. If, however, it approaches that response from a different angle even within the same issue, then this is to be considered as a new initiation. Another methodological clue that can help in this respect is to keep bearing in mind that the act of the elaboration falls upon the response and not the respondent. If the teacher, for example, is exchanging a long talk with one pupil, then this does not mean that all the teacher's responses to the pupil's answers (apart from the E_v & C₀ types) have to be elaborative follow-ups. They can be simply new initiations that approach the issue from different angles (as mentioned) but directed still to the same pupil. On the contrary, the teacher might be elaborating a certain response offered by a first pupil, but s/he chooses to engage a second pupil to direct the elaborative question to.
- **Comment Follow-up (C₀)** is a neutral utterance given by a second speaker in response to a first speaker's answer. It can take the form of repeating, restating, rephrasing the first speaker's answer (Chin, 2006, p. 1322). This means that this type comes in the middle of the two extents of closing the response by evaluating it, or extending the response by elaborating it. It rarely happens that in talk initiated by pupils, the 'Comment' move follows a first speaker's initiation (I-C₀), and not a response (R-C₀). In other cases, it can be mutually practised by both the teacher and pupils following each others' comments regarding a certain point (C_{0T}-C_{0S}).

Cell 7: the final cell in this part is allocated for remarks describing the context, which I believe are essential to help the reader to follow the analysis. There are two types of context here:

1. Teaching/discourse context: one of the key means for this framework to explicitly put light on the analysed teaching context is through this cell. Practically, I refer to the gestures, intonations, punctuations and any observations that I am aware of and which I believe are useful to be mentioned regarding an utterance in a certain turn. In fact, revealing information about the context explicitly through this cell as well as through the qualitative account in part four (section 3.1.4), or using it implicitly to determine the categorisation in all the different cells and parts of this framework; in doing this, I use whatever information I get to know about the teaching context, following Mercer's description of the context as "a mental phenomenon" consisting of "whatever information listeners (or readers) use to make sense of what is said (or written)" (Mercer, 2006, p. 20).
2. Analysis context: this cell also offers some information about the methodological context of the analysis concerning the categorisation of the different moves such as the quality of questions and responses. Such remarks are expected to help the reader to follow the analysis by clarifying why certain decisions or judgments have been taken. Certainly, this kind of context is influenced by the teaching/discourse context, and the two are greatly important to meet the norms of the sociocultural tradition of research and the qualitative perspective of analysis, and contribute to enhancing the trustworthiness of the study (see section 5.9).

These remarks are indicated by a number of *transcription symbols*, indicating 'non-language' stuff (refer to section 2.1.3) such as hesitation, wonder tone, gestures, and any contextual information that I considered pertinent to the analysis. These symbols have been chosen for the needs of this study, not borrowed hence from any referenced source. Although the different symbols are pointed out in the remarks cell somewhere throughout the transcription of each case- to make it easier for the reader to follow their meanings and indications (see the example in section 3.2), I put them in a list attached to appendix 1 that contains the framework analysis. It is worth mentioning, that I decided not to include some other additional information found sometimes in conversation analysis, such as length of pauses, in fear of distracting the reader, and based on my judgment of their irrelevance to the issues addressed in the analysis of this study.

3.1.2 Part two: Characterising the talk

This part is set to characterise CT in relation to four aspects; the class, purpose, content and pattern of the talk. It is based on the work of Mortimer and Scott (2003) in which they introduced their analytical framework for characterising CT (refer to section 2.2.3.2). However, there are small differences between the two, which I highlight through the following account of the four aspects constituting this part:

1- Class of the talk: this is based on characterising CT into the four classes of the CA. In doing this, I followed the theoretical guidance offered by Mortimer and Scott (2003) as well as their practical application of it throughout their book and other successive work (e.g. Scott & Ametller, 2007; Scott et al., 2006). However, I expanded the implementation of this approach to the talk initiated by pupils. Mortimer and Scott introduced the CA to characterise only the talk initiated by teachers, not including therefore the other two forms of CT; the talk exchanged between the teacher and pupils but initiated basically by pupils, and the talk taking place between pupils only during group work/discussion. As the verbal and intellectual authority of the teacher is the core heart of the CA, it is not possible to apply it to group discussions due to the absence of the teacher. However, I believed that the CA can work with the talk initiated by pupils as the authority of the teacher can still be assessed in terms of his/her response to the pupils' questions and the general influence s/he practises in shaping and guiding the talk. Hence, the CA has been used in this study to characterise the talk initiated by pupils in addition to the one initiated by the teacher⁷ (see section 5.8.1).

2- Purpose of the talk: Mortimer and Scott (2003) introduced six teaching purposes (refer to section 2.2.3.2); 'Opening up a problem' ... 'Maintaining the development of the scientific story' (p.33). The attempt to define the purposes of a variety of episodes from different lessons and different cases from the Omani context, however, showed that the predicted purposes were too diverse to be confined to those specific ones. I decided therefore to rely on an open classification in describing the purposes of the talk, within three general labels of:

- Opening up the problem/idea/notion/topic (opening-up, introducing, describing, exploring, ...)
- Working on the problem/idea/notion/topic (explaining, justifying, developing, ...)
- Closing down the problem/idea/notion/topic (generalising, reviewing, applying, concluding,...)

On the other hand, I believe that we cannot really know the purpose of the teacher in each

⁷ I took these decisions under the supervision and with the approval of Phil Scott, my supervisor, and one of the two authors who introduced the CA (Mortimer & Scott, 2003).

excerpt of talk. What we do instead is to infer the purpose of the talk as shaped by various contextual information. This inference can be based on the way the teacher intervenes to develop certain ideas (referring to what Mortimer and Scott (2003) mean by the fifth aspect of teacher intervention, p. 42, in which there are six categories ranging from 'Shaping ideas' to 'Reviewing ideas', p. 45). Consequently, I chose to refer to this aspect as the purpose of the talk instead of the teaching purpose. As the purpose of talk is to be inferred from the context of the interaction, it is to be also based on the way(s) the teacher seems to intervene in developing this talk. Accordingly, this framework does not include the aspect of teaching intervention *per se* (as in Mortimer and Scott's framework) because it is implemented in defining the purpose of the talk.

3- Content of the talk: in Mortimer and Scott's (2003) framework, the analysis of this aspect is specified with three categories (pp. 29-33):

- everyday-scientific
- description-explanation-generalisation
- empirical-theoretical

This framework is adopting the first and the third categories as defined and utilised by the authors (see pp. 29-33 for more details). The decision of not including the second category is based on taking a different position in perceiving its three sub-categories. Mortimer and Scott (2003) referred to these sub-categories as describing “fundamental features of the scientific social language” (p. 30). However, I adopt a different theoretical position. I perceive these sub-categories as to describe some functions of the scientific social language as utilised by the teacher and pupils in their talking about the content, whether scientific or everyday, empirical or theoretical. With such perception, these functions are to reflect how the teacher intervenes in developing an exchange of talk which helps, in turn, in deciding about the purpose of the talk as explained in the aforementioned aspect. Regarding the two subcategories of everyday/scientific and theoretical/empirical, I believe the two are central to characterising the content of CT, as they describe important features of the subject of science. It would be also useful and interesting to examine how different types of talk can be specified, influenced or shaped by everyday or scientific and theoretical or empirical content.

4- Patterns of the talk: part one includes the categorisation of the moves as an Initiation, Response or a Follow-up (whether Evaluation, Comment or Elaboration). Here, I follow the different moves for each class of the talk in a certain example, and put them in their order of occurrence in what is called the pattern of talk/discourse/interaction. Certainly, the patterns expected to be illustrated by the analysis will entail the triadic I-R-E pattern or alternative ones like the chain of I-R-F-R-F interaction demonstrated by Mortimer and Scott (2003) (refer to section 2.2.3.2), as reflecting Authoritative and Dialogic talk respectively.

Nevertheless, this analysis is expected to demonstrate a variety of patterns due to several reasons:

- working on two types of teacher-pupil talk; the talk initiated by the teacher and the talk initiated by the pupils;
- working on a large number of examples, different in their length, number of participants and kind of interaction;
- indicating the moves by the participant (e.g. R₁) and his/her number of participation (e.g. R_{1.1}, R_{1.2});
- Indicating the move by the type of the follow-up: E_v , C₀ , E_L.

3.1.3 Part three: Quantifying the quality

In this part, I quantify the quality of the moves in the Interactive Authoritative and Dialogic classes of talk⁸. It includes information about the overall number of questions and responses of low and high quality manifested in a certain type of talk in a certain example. It also shows the overall number of the follow-ups divided into the types of evaluation, comment and elaboration. By doing such quantification, the chance is there to capture any quantitative indicators in characterising different types of talk (table 3.3).

Class of talk	Question (Cognitive level)		Response (Cognitive Level)		Follow-up		
	Low	High	Low	High	E _v	C ₀	E _L
Authoritative / Dialogic							

Table 3.3: The quantitative part of the framework

3.1.4 Part four: Narrative account

This is the part in which I provide a narrative account of the analysed excerpts based on the detailed information provided by the analysis in the first three parts, and in view of what is known about their context. As in any qualitative analysis, this account can be open to different kinds of theorisations, and it can be very difficult to establish relations between its parts. In the light of such difficulties, I attempted to draw this account around the class of the talk, and relate it to the other aspects that this framework is based on. Thus, this account is guided by the following points of discussion:

- Class of talk (turn-taking, power-relation, ...)
- Class of talk in relation to the purpose
- Class of talk in relation to the content
- Class of talk in relation to the kind and pattern of moves

⁸ Non-interactive parts are not quantitatively represented because they consist of one move only (F move). In the few incidents when the teacher includes one pupil in the talk just to support what she wants to say, I chose to still deal with it as one move (see such an incident with more explanation in the example provided in section 3.2).

- Class of talk in relation to the learning

For each set of the excerpts selected from each lesson to go through the framework analysis (see section 5.8.2), there is one whole qualitative account explaining the story behind those examples. For each case at each stage (see Chapter 5: Methodology), five sets of qualitative accounts have been produced because five lessons in total have been followed. The example in the next section illustrates the analysis of the selected examples from one lesson, and clarifies what is included in this narrative part.

3.2 Example of application

The framework has been applied to selected excerpts of recorded CT in Omani science lessons (see Chapter 5: Methodology) through a second stage of analysis named ‘deep analysis’ (see section 5.8.2). It was a long process that resulted in more than 100 pages of detailed discourse analysis of the selected examples. This required a third stage of analysis (see section 5.8.3) to put the details together to reach the themes discussed in the analysis chapters.

Although I provided the details above regarding the different elements/specifications of the framework, applying those specifications to analysing different examples of CT was neither a straightforward nor a simple task. Most crucially, as the adopted approach to discourse analysis- reflected in implementing this framework- is built around the meaning of the talk to be the object of analysis (refer to section 2.3.1), careful attention needed to be paid to understand the context of each analysed excerpt of CT.

Certainly my analysis of the selected examples is limited by the elements constituting the framework as well as by my application of it. I tried to perform as precise an analysis as possible, following the discussed specifications. As expected, I faced difficulties and confusion with the analysis of some excerpts. Most of those difficulties appeared with classifying CT into the CA classes (refer to section 3.1.2 above) and categorising the type of move (I, R or F and type of F) and its quality (low or high cognitive level). In such incidents, the analysed examples involved extensive discussion between me and my supervisors and careful review of their context until agreement was reached.

Eventually, I used the ‘Contextual Remarks’ (cell 7 in part 1) to highlight the quality of categorisation in general, and any decision for any categorisation that I felt looks unusual and needs to be clarified. As pointed out above, judging the quality is never absolute. In the remarks cell therefore, I offered the inferred cognitive processes for most of the questions and responses unless they are very obvious or reflected by previously explained ones. Although different opinions can be made regarding the sub-cognitive processes (e.g. ‘Remember’ process has two sub-processes: recognise – recall), relying only on the general

judgment of high or low made this kind of analysis more reliable, as it is most probable to agree over the same judgment of low or high (as happened between me and my supervisors over the discussed examples). Moreover, there were some which had not been categorised, and for which I also provided the justification in the remarks cell.

Nevertheless, it is not possible, neither is it necessary, to include the justifications of every categorisation (given especially the amount of the analysed data). I believe that having all the four parts together explaining the analysed excerpt from different angles (with the last part presenting a narrative account of the analysis) contributes to understanding the excerpt's context and, with anticipation, helps to understand the designated categorisation. Moreover, all of this analysis is made available in appendix one for the reader to follow.

I offer next an example of the framework application to one lesson (lesson 4, case 1, stage 2), including different excerpts taken as a whole example, to demonstrate how the four parts of analysis work. In this example, the teacher and pupils are discussing a practical activity of a simple electric circuit with very long wires. This activity was conducted in the previous lesson to examine if the bulb will light instantly or not. The pupils saw that it does. In this lesson, they are trying to explain this instant lighting in relation to the source of the charges and how they move in the circuit.

Analysis of Case 2, Stage 1, Lesson 4, Episode 1,2

1. Analysing the talk

S	Utterance	Move	I	R	F	Remarks
1.T	...so there're negative charges that go in the bulb. Where do they come from?	I	H			...T is continuing a discussion about; why the bulb lights instantly, after performing two activities with long and short wires * H: CP of 'Analyse; break down'
2.S ₁	Because of the movement. I mean because of the battery, that we put there, there will be a (...?) between the wire and the battery - from the wire they came	R _{1,1}		H		* H: CP of Analyse; break-down' (...?) inaudible - pause
3.T	So they'll come from the wire? They don't come from here? ()	F	H		E _L	() T points to the battery
4.S ₁	I mean when they go there, the battery will give negative charges but will enter from there ()	R _{1,2}		L		() S ₁ points to the part of the circuit near the bulb, but T seems not to hear it * L: usual misconception
5.T	So still the battery will give charges	F	L		E _L	
6.S ₁	Negative. But that pole doesn't give, it will get from the bulb	R _{1,3}		L		Pole : the positive pole in battery * L: usual thought in its context
7.T	Ok, this will get from the bulb. The battery will give negative charges () and these negative charges will go to? The bulb. In their way like this, moving, moving, moving, doesn't it take a time?	F	H		E _L	() S ₁ is nodding yeah * H: CP of 'Understand, explain'
8.S ₁	No, no, cause when they move - when we switch on they'll enter from there ()	R _{1,4}		H		() S ₁ points again to the part of the circuit near the bulb * H: CP of 'Create; hypothesise'
9.T	So when these moves these will move? ()	F	H		E _L	() points to: 1 st these, charges near the battery, 2 nd these, charges near the bulb
10.S ₁	Yeah	R _{1,5}		H		
11.T	At the same time? () These and these will move together? () What do you think girls? S ₁ is saying... So you do explain by this the instant lighting? () What do you think S ₂ ?	F, R _{1,6} F, R _{1,7} F I, R _{1,8} I	- - - - H	- - - - H	E _L E _L C ₀	() S ₁ is nodding yeah () S ₁ is nodding yeah ... repeat the point (NI/D) () S ₁ is nodding yeah - not categorised: confirm previous answers * H: CP of 'Create; generate hypothesis'
12.S ₂	Maybe the charges are basically moving on their own from the beginning	R _{2,1}		H		* H: CP of 'Create; hypothesise'
13.T	Do you agree or disagree with S ₁ ?	I	H			* H: CP of Evaluate; judge'

14.S ₂	A little (). Basically it has – the charges are moving there from the beginning	R _{2.2}		H		() laughs , - pause * H: CP of 'Create; hypothesise'
15.T	Where do they move?	F	H		E _L	* H: CP of 'Understand; explain'
16.S ₂	They move in the wire^ and go to the bulb	R _{2.3}		H		^ affirmation tone * H: CP of 'Create; hypothesise'
17.T	So when the circuit is opened, the charges are moving	F		H	E _L	* CP of 'Understand; explain'
18.S ₂	No, it's not they're moving. I mean it must - once the switch is off, the charges will meet together and complete the movement around. They move around, but. They move around - they don't move around in the wire	R _{2.4}		-		- pause with hesitation * not categorised: answer is confused - pause with hesitation
19.T	Where do they move around?	F	H		E _L	* H; CP of 'Understand; explain'
20.S ₂	I mean they're there - there ()	R _{2.5}		H		-pause , () girls laugh
21.T	They're there. If we take part of this wire and zoom it, and saw the charges there as S ₁ has said. Now you're saying they're moving around, where?	F	H		E _L	* H: CP of 'Understand; explain'
22.S ₂	They move there, in their places	R _{2.6}		H		*H : CP of 'Analyse; organise'
23.T	Their place ...	F	-		E _L	...skip some turns in which S ₂ looks like thinking aloud about the battery and the bulb, but she changes her mind to come again to the charges in the wire.
24.S ₂	No, they're there. It, it - the wire, and once we close it they'll continue their movement. Maybe they were - but when opened - once we close it the movement will keep on	R _{2.7}		H		- pause *H : CP of 'Analyse; organise'
25.T	How they're when it's opened? You're saying they move. How it is this movement? I just want you to explain this point	F	H		E _L	* H: CP of 'Understand; explain'
26.S ₂	They're moving in the wire	R _{2.8}		H		*H: CP of 'Understand; explain'
27.T	In the wire, in which direction?	F	H		E _L	*H: CP of 'Understand; explain'
28.S ₂	Umm - maybe - () No, not randomly. Maybe this direction	R _{2.9} R ₃		L H		- pause, () S ₃ is saying randomly (H) * L for R _{2.9}
29.T	So they're moving in a directed way	F	H		E _L	* H: CP of 'Understand; infer'
30.S ₂	No- they can't be ---	R _{2.10}		H		- pause, ---silence *H : CP of 'Analyse; organise'
31.T	S ₃ is saying randomly, what do you think?	F	H		E _L	*H : CP of 'Evaluate; check'
32.S ₂	Randomly?! - No #	R _{2.11}		L		- pause, # S ₂ is interrupted by T
33.T	So directionally, they move in a directed way	F	H		E _L	*H: CP of 'Understand; explain'
34.S ₂	No - I don't know how -Maybe randomly --- And after we close the circuit they will move around - before they don't move around	R _{2.12}		H		- pause --- silence *H: CP of 'Analyse; organise'

35.T	Ok, thanks S ₂ , have a seat. S ₂ is saying that the charges are moving randomly. Once we close the circuit, they will enter the bulb and it lights. Ok? And S ₁ said that they are there basically, just near the bulb and when the switch is off. They will go inside the bulb - so S ₁ what do you think, when they were there near the bulb, were they moving? Or they just started moving when we closed the circuit?	F I			C ₀	- pause *H: CP of 'Analyse; break down'
36.S ₁	They move. In their places, but when we close it, they'll move. They'll move from the battery through the wires...	R _{1,9} ...		H		...skip some turns which show S ₁ thinking about charges from the battery and the wire *H: although her idea about the battery and the wire together giving charges, but her answer shows an analytical thinking
37.T	Ok, this is enough, enough. Let's try to explain now one thing, why do the bulb lights instantly, but before, we need to see the situation of the charges before the circuit is closed, and their situation after the circuit is closed? Ok? Let's see this flash (). It will help to explain things. Ok? pay attention. Now, you see this electric circuit? Is it closed or opened? And why?	F I		L	C ₀	() T switches off the lights of the class and displays the flash * L: about direct observation from the flash
38.S ₄	It's closed, cause there is no gap there ()	R _{4,1}		L		() actually the switch is on
39.T	There is no gap. Ok, if it's closed, we're not supposed to see something?	F	H		E _L	* H: CP of 'Apply; execute'
40.S ₄	The bulb lights	R _{4,2}		H		* H: CP of 'Apply; execute'
41.T	So, is it closed?	F	L		E _L	* L: about direct observation from the flash
42.S ₄	Opened, cause the bulb doesn't light	R _{4,3}		L		
43.T	Good. Now, this circuit contains two kinds of conductors that we mentioned in the last lesson. The matters that conduct (or convey) the electric current. We mentioned metals as conductors and which other type? In the first lesson, we talked about the matters that conduct the electric circuit	F I		L	E _v	*L: CP of: 'Remember; recall'
44.S ₅	Salts	R _{5,1}		L		
45.T	Salts, or ionic solution, a solution that has what? (). But when the salts dissolve in water, they produce something? What? S ₅	F, I, R _g , I	L L	L	E _v	() group of pupils answer: salts *L: CP of: 'Remember; recall'
46.S ₅	Negative and positive ions	R _{5,2}		L		*L: CP of: 'Remember; recall'
47.T	So I can take sodium chloride and dissolve it in water? What kind of ions will I get? S ₆	F	L		E _L	
48.S ₆	Positive ion of sodium and negative ion of chloride	R ₆		L		
49.T	Excellent. ...This is the solution I'm talking about...let's zoom in...let's focus on the movement of...describe what happens now...	F			E _v	...An NI/A talk continue, then again, T starts to ask questions interactively

2. Characterising the talk

Class of the talk	<u>Teacher-Pupil talk</u>	
	<ul style="list-style-type: none"> - Example1, Turns 1-11 : I/D - Turn 11: NI/D <li style="padding-left: 20px;">Turns 11-35: I/D - Turn 35: NI/D <li style="padding-left: 20px;">Turns 35-37: I/D - Turn 37: NI/A <li style="padding-left: 20px;">Turns 37-49: I/A - Turn 49: NI/A 	
Purpose of the talk	<ul style="list-style-type: none"> - I/D1,2,3: Justifying a scientific observation using pupils' ideas - NI/D1,2 : Reviewing pupils' ideas - NI/A, 1: Introducing a scientific design to explain the scientific observation - I/A: Exploring the scientific design - NI/A,2: Describing the scientific design 	
Content of the talk	<ul style="list-style-type: none"> - Dialogic talk: Personal views of Theoretical Scientific subject matter - Authoritative talk: Scientific view of Theoretical/Empirical Scientific subject matter 	
Pattern of the talk	<ul style="list-style-type: none"> - I/D: I-R_{1.1}-E_L-R_{1.2}-E_L-R_{1.3}-E_L-R_{1.4}-E_L-R_{1.5}-E_L-R_{1.6}-E_L-R_{1.7}-C₀ - NI/D: C₀-I-R_{1.8} - I/D: I-R_{2.1}-I-R_{2.2}-E_L-R_{2.3}-E_L-R_{2.4}-E_L-R_{2.5}-E_L-R_{2.6}-E_L-R_{2.7}-E_L-R_{2.8}-E_L-R_{2.9}-R₃-E_L-R_{2.10}-E_L-R_{2.11}-E_L-R_{2.12}-C₀ - NI/D:--- - I/D: I-R_{1.9}-...-C₀ (R and E_L) - NI/A: --- - I/A: I-R_{4.1}-E_L-R_{4.2}-E_L-R_{4.3}-E_v-I-R_{5.1}-E_v-I-R_g-I-R_{5.2}-E_L-R₆-E_v - NI/A: --- 	

3. Quantitative indicators

Class of talk	Question (Cognitive level)		Response (Cognitive Level)		Follow-up		
	Low	High	Low	High	E _v	C ₀	E _L
Dialogic 1	1	4	2	3		1	6
Dialogic 2		10	2	10		1	10
Dialogic 3		1		1		1	
Authoritative	6	1	6	1	3		3

4. Narrative account

The example from this lesson is a very long one that entails seven shifts between the different classes of talk. At the end of the previous lesson, the teacher challenged the pupils' thinking by suggesting the 'big circuit' activity to examine if the bulb will light instantly if the circuit is connected by very long wires. They carried out the activity, and had seen that it does. In this example, the pupils are trying to justify the instant lighting.

Four pupils in total had offered their opinions. This example entails the opinions of the last two pupils, not including hence the first two ones. As it is obvious, the teacher exchanged a long talk with both pupils and tried to put their thoughts together. This can be spotted out in turn 35 when she initiated the talk again with S₁, asking for her view in relation to what S₂ had proposed. Overall, the discussion with these two pupils went through four shifts between the two classes of Dialogic talk: I/D to NI/D to I/D to NI/D to I/D. All the I/D talk went on with the purpose of justifying the scientific observation of the instant lighting using pupils' ideas and thoughts. In the NI/D ones, the purpose of the talk was to review the ideas raised in the I/D talk. Consequently, the content of all of this Dialogic talk entailed personal views of theoretical scientific subject matter. After the last I/D, the teacher took control over the talk verbally and intellectually to introduce a scientific design, as will be discussed later on. Subsequently, the content shifted to entail the theoretical subject matter and complement it with empirical content that could explain and support the scientific view.

In their attempt to justify the instant lighting, the pupils knew that they needed to hypothesise not only the source of the charges, but also the nature of the charges' movement and how they reach the bulb instantly. The first two pupils tried to attribute this to a very high speed of charges, so that it takes the charges a very short time to reach the bulb, and we as human beings will see the bulb light instantly. However, the opinions of the two pupils included here try to attribute the instant lighting to the charges in the wires in terms of their places and kinetic situation prior to the connection of the whole circuit.

We have seen in the previous lesson how the class had approved the initial idea of the battery as the source of charges, that when the unexpected idea of wires as a source was offered, the teacher tried to challenge it to encourage the rest of the class to think deeply about it. We have also seen that another pupil supported the idea and tried to justify it. A second pupil also supported it without abandoning, however, the idea of the battery as a source. The teacher has not provided any evaluation for these opinions. Therefore, the uncertainty about the source of charges continues through the talk of this lesson. However, it seems that the idea of the wires as a source has found a place in the pupils' minds even without being approved by the teacher. The justification for this idea that has been provided by the pupils in the previous lesson seems to have convinced some in the class.

Although S₁ here still mixes it up with the battery as a source, she is trying to use the idea of the wire as a source to justify the instant lighting. S₂ is going further in thinking not about the charges existing in the wires but of them as moving in the wire as well. Surprisingly, S₂ is the same pupil as S₅ in the previous lesson, who presented very strongly her view of the battery as a source and denied that the wire would have charges. One of the advantages of the Dialogic talk therefore is that it gives the chance for the pupils not only to come up with extraordinary scientific ideas, but also allows these ideas to be assimilated by other pupils without being confirmed and explained by the teacher.

In addition, when these ideas are challenged through the Dialogic talk itself and in relation to scientific observations, they develop to a higher level to answer more difficult questions and to reveal more complicated scientific facts. S₁'s and S₂'s responses in this example demonstrate such development of ideas. Yes, both of them were showing hesitation when presenting their remarkable ideas, but then, hesitation might be expected in offering such ideas. In spite of their uncertainty, they still ended up with those ideas. Although S₁ mixed up things, she repeated twice that charges; 'will enter from there' (turns 4 and 8) and insisted on her view when the teacher kept challenging her in turn 11. Similarly, we see S₂- in what it seems that she is talking to herself and challenging her thoughts, come back again and again to the same point:

- 'They move in the wire' (turn 16)
- 'They're there. There' (turn 20)
- 'They move there, in their places' (turn 22)...
- 'No, not randomly. Maybe this direction ... No, they can't be' (turns 28 & 30)
- 'Randomly?! -No... I don't know. Maybe randomly' (turns 32 & 34)

What is remarkable about the teacher here is that she was giving them the chance to think and re-think aloud. In her elaboration of their answers, she was trying to make them deconstruct their thoughts, analyse and organise them in order to develop them towards a more logical account that will eventually lead to the scientific view. This means that the teacher was not using the Dialogic talk just to explore the pupils' ideas. She was actually motivating the pupils indirectly to themselves explore their ideas and check them for logic and consistency in justifying scientific facts. She was approaching the scientific view by motivating the pupils to develop their thoughts by re-thinking aloud.

It is not surprising, therefore, that the sequence of (I-R-E_L-R-E_L ... -C₀) repeats itself through the pattern of moves in the three Interactive-Dialogic parts:

- I/D, 1: I-R_{1.1}-E_L-R_{1.2}-E_L-R_{1.3}-E_L-R_{1.4}-E_L-R_{1.5}-E_L-R_{1.6}-E_L-R_{1.7}-C₀
- I/D,2: I-R_{2.1}-I-R_{2.2}-E_L-R_{2.3}-E_L-R_{2.4}-E_L-R_{2.5}-E_L-R_{2.6}-E_L-R_{2.7}-E_L-R_{2.8}-E_L-R_{2.9}-R₃-E_L-R_{2.10}-E_L-R_{2.11}-E_L-R_{2.12}-C₀
- I/D, 3: I-R_{1.9}-...-C₀ (R and E_L)

After listening to many and different opinions regarding the five questions and what followed, the teacher decided to take control over the talk and to present the scientific views in relation to all the questions posed. She planned to do so by displaying a computer flash that shows the situation of the whole electric circuit in general, and the situation of the charges in particular before and after the circuit is connected. Therefore, she practised a Non-Interactive Authoritative talk (turn 37) first to introduce this scientific design. Then she allowed the participation of some pupils to explore and set the scene of the displayed flash (turns 37-49) before she again takes verbal control over the talk to describe what happens exactly in the electric circuit using the playing flash (turn 49). The content of these Authoritative parts was of scientific views regarding theoretical and empirical scientific subject matter. Consequently, the shift from Dialogic to Authoritative talk witnessed a shift in the kind of the content from personal to scientific view, and from only theoretical scientific subject matter to theoretical and empirical subject matter, as the teacher was using the flash to show what happens empirically inside the circuit.

Regarding the pattern of discourse in this Authoritative part, we can see that a similar sequence to the one noticed in the Dialogic parts exists here. Instead of the comment follow-up move in the conventional sequence of Dialogic classes: (I-R-E_L-R-E_L...-C₀), the evaluative follow-up move persists in the Authoritative one: (I-R-E_L-R-E_L...-E_v). Although the elaborative move repeats in the Authoritative excerpts, it is considerably less frequent than in the Dialogic one: I-R_{4,1}-E_L-R_{4,2}-E_L-R_{4,3}-E_v-I-R_{5,1}-E_v-I-R_g-I-R_{5,2}-E_L-R₆-E_v.

In terms of the quality of questions and responses, the quantitative indicators illustrate how the Dialogic talk is dominated by moves of high quality compared to the Authoritative talk that is almost devoid of them. Even those moves of low quality in Dialogic talk are valuable because they reflect the pupils' personal views to the discussed issue, and they still hold to some kind of thinking even if they do not seem to reflect high cognitive processes. The pupils' answers in the Authoritative examples might also reflect their thoughts. However, they might sometimes hide the pupils' thoughts as they are uttered just to match what is considered a scientific view.

The next chapter offers a general description of the Omani context, for the reader to be able to follow some of the empirical study details presented in Chapter 5 of the methodology.

4 CHAPTER 4: THE OMANI EDUCATIONAL CONTEXT

As has been explained in the first chapter, the concern of the study has shifted away from scrutinising the teaching practice in the Omani context. It is no longer about describing the teaching in Omani science classes in relation to how much dialogic practice it shows (refer to section 1.1). Yet I believe that explaining about the Omani educational context in this report is needed as it is part of the whole context of the CT to be analysed and characterised. However, this account does not go into depth, giving rather a very general description of what I consider is relatively helpful in setting the scene for the research methodology and the data analysis. Although this is a very short account that could be included in the next methodology chapter, I thought it blocks mentally the progress of the account on the research design and implementation, and decided hence to separate it into a different chapter.

4.1 The Omani educational context

4.1.1 The Omani educational setting

With three schools existing in 1970, providing education for only “909 students, all male and all at the primary level” (MOE, 2006, p. 25), the journey to today’s formal and modern education in Oman started with the ascension to the throne of His Majesty Sultan Qaboos. This journey was started by establishing the Ministry of Education (henceforth MOE) to be responsible for all educational matters in the Sultanate. Immediately, the Ministry adopted three key strategies to define the prospect of education in Oman. These are:

- Universal education
- Diversification of education
- The introduction of female education (MOE, 2001)

At this stage also, the MOE identified the country’s philosophy of education as to distinguish Oman “from other nations as it shapes its style of life, forms its visions for the future and marks its plans in different fields” (MOE, 2004b, p. 13). The first document addressing this philosophy was published in 1978, and since then it has been subject to “reviewing and modification in accordance with the trends, plans and objectives of the government” (MOE, 2001, p. 13).

It can be said, generally, that the education system has gone through two major phases; the first from 1970 to the mid-1990s, and from then till today constitutes the second one. The first phase was dedicated to the quantitative expansion of the educational provision to all parts of the country. This was a priority in the government’s plan to provide all sections of society with equal access to education. By the mid-1990s, after the success in achieving the desired quantitative infrastructure and provision, attention has been shifted towards the

qualitative improvement of the education system (MOE, 2004a). This phase was started, literally, by the initiation of the education reform in 1998. In the following sections, I shall attempt to draw a simple picture of the main features of the education systems during the two phases. My study is taking place within the context of the new education system. It would be useful, though, to highlight some of the differences between the two.

4.1.2 The pre-reform education system

The situation in which the education system in this phase was introduced, was exceptionally critical and challenging. At that period, Oman was lacking the very minute infrastructure for initiating a formal education. In response to this, the MOE had to plan short-term solutions (e.g. opening schools in tents and rented building, establishing a system of “double shift” schools, borrowing books from other Arab countries, employing staff from other countries (MOE, 2001)). These solutions lasted, in fact, for more than a short time to complement the expansion of the educational services to the whole region of the Sultanate. Great attention, however, has been directed towards going past this temporary situation. This has been achieved by: providing the required physical infrastructure, designing Omani curricula and subject syllabi, and qualifying a cadre of educational personnel from which to draw teachers and administrators. The schooling system at this period was called “General Education”. It was organised into three stages (see table 4.1): elementary (grade levels 1-6), preparatory (grade levels 7-9) and secondary (grade levels 11-12). It had gone, actually, through a developmental process in accordance with the Five Year Plans made by the government to guide the work in the different sectors (Al-Ghafri, 2002). Although this system has its limitations in terms of the quality of the implemented education, it succeeded in achieving its stated objectives based on the principle of offering education for all and within an educational institution that has its own established vision and philosophy (MOE, 2006).

4.1.3 The post-reform education system

By 1995, the Ministry began to shift its emphasis from quantity to quality in education. This was driven by two recent developments of international attribute; globalisation, and national requirement; Omanisation (MOE, 2006). It was agreed that the reform should involve the whole education system, starting from the weekly timetable of schools and continuing to the organisation of the MOE itself. The vision of the development was formulated by the MOE based on the recommendations of research and conferences, among which was the Oman Economic Vision 2020 conference. One of the key resolutions of this conference was to establish “a strong foundation of Basic Education nationwide” (MOE, 2001, p. 11).

The ambitious project of Basic Education (henceforth BE) was first applied in the academic year 1998-1999. It is defined as “a 10 year unified education provided by the State for all

children of school age” (ibid, p. 14). Within these 10 years, two stages have been identified, Cycle One (grades 1-4) and Cycle Two (grades 5-10). Grades 11 and 12, however, are considered to be Post BE, in which pupils are given the opportunity to decide their learning demands in light of their aspirations. The BE programme has been organised to gradually replace the three levels of the GE system (table 4.1).

Grade level	Stages	Grade level	Stages
12	General Education (Secondary)	12	Post Basic Education
11		11	
10		General Education (preparatory)	10
9	9		
8	8		
7	7		
6	General Education (Elementary)	6	Basic Education (Cycle One)
5		5	
4		4	
3		3	
2		2	
1		1	

Table 4.1: Structure of Basic Education and General Education

The development of this system has been accompanied by several quantitative and qualitative requirements. I shall emphasise the curriculum development only, in which I focus on teaching and learning strategies, as they are the most related to the interest of this study.

4.1.3.1 The development of curriculum

The curricula for the different subjects have been developed in accordance with the principles of the ‘Philosophy of Education’ that has been updated to aspire to the Omani developmental needs and the international trends (MOE, 2001). Among these principles are those which emphasise the adoption of scientific thinking and modern technology, some of which are to:

- develop the ability of individual to use a scientific thinking approach in different life situations, and inflame the spirit of scientific research
- develop the ability of critical thinking
- develop the ability to innovate and create
- develop the ability to deal with science and technology (MOE, 2004b, pp. 51-53)

Following the principles of the philosophy, the BE system has been designed to offer qualitative improvements, among which are (MOE, 2006, p. 100):

- the strengthening of key subjects, such as science ...
- the development of teaching and learning materials that adopt a student-centred approach
- the revision of courses, school textbooks and teacher guides in order to reduce theoretical content and increase real-life applications that are meaningful to students

In following these broad lines, the learning materials have been designed to enhance the pupils' ability to find, use and understand, rather than remembering the information. Their content has also been developed from being overloaded with theory and abstract concepts to be "based on practical and real-life contexts and applications, and provide students with opportunities for experiential learning" (MOE, 2006, p. 102). The content of the science syllabus represents, in fact, a potential example of these features. In the 'General Education' system, the teacher-centred approaches to teaching and learning tended to be dominant. The over-reliance on such methods, however, was believed to lessen the participation of students in the teaching and learning process, and encouraged them to become passive learners who are dependent on the teacher to tell them what and when to learn (MOE, 2004a). It was decided, therefore, that the BE programme should support a student-centred rather than a teacher-centred approach to teaching and learning, involving, for example:

- focusing on student-centred learning. Students are at the centre of the teaching and learning situation. They should therefore be provided with the necessary strategies which will enable them to rely on their own abilities in the acquisition of knowledge and skills.
- focusing on cooperative learning through involvement of students in tutorials, as determined by the nature of the individual subject.
- avoiding traditional methods of narration, lecturing, student recitation and rote learning, and respecting the students' right to express opinions, ask questions and voice their personal experience. These are important measures that help students acquire higher order and critical thinking skills from the earliest stages of their development. (MOE, 2001, p. 44)

In response to these requirements of teaching and learning, the aim of the BE has been drawn, generally, as to "create a learning environment in which students learn how to learn, providing them with the required tools for life-long learning" (MOE, 2006, p. 102).

The account above then is a very general description of the Omani educational system as drawn by the Ministry's official documents. This study is taking place in Cycle Two BE schools.

The next chapter explains the research design and methodology.

5 CHAPTER 5: RESEARCH QUESTIONS AND METHODOLOGY

This chapter outlines the empirical research design and methodology. It begins by stating the research questions (5.1) and explaining the research stance, its approach and method (5.2). It addresses then the research design (5.3), sample (5.4) and implemented techniques (5.5). Descriptions of the processes of data generation (5.6), data reduction (5.7) and data analysis (5.8) are then presented. This is followed by commenting on the issues related to trustworthiness (5.9) and ethical considerations (5.10), to end with a brief summary (5.11). It is worth mentioning before going on into the details, that a pilot study was performed, and a report has been written on it. This chapter does not include this report. Nevertheless, all the outcomes of the pilot that have affected the planning and doing of the main study are referred to throughout this chapter, each in its relevant section. The report itself is included in appendix 5.

5.1 Research questions

Given the insights provided in the literature review and the developed framework, and in view of the two aims and their steps of research explained at the end of the literature review chapter (section 2.4), the study looks to answer the following research questions in relation to the two main aims of:

1. Characterising CT from the Dialogicity perspective in relation to the Authoritative-Dialogic classification of talk:
 - 1.1 What classes of communicative approach does the recorded CT exhibit?
 - 1.2 What features of Authoritative and Dialogic communicative approaches are revealed by the implementation of the analytical framework?
 - 1.3 Reflecting on the outcomes of 1.1 & 1.2, how can CT Dialogicity be conceptualised both theoretically and empirically, in relation to the existing relevant literature?
2. Investigating the relationship between the characterised Dialogicity of CT and pupils' learning:
 - 2.1 What indicators of the potential of Authoritative and Dialogic communicative approaches to support pupils' learning are revealed by the implementation of the analytical framework?
 - 2.2 What evidence is there of pupils' conceptual understanding, following the observed teaching?
 - 2.3 Reflecting on the outcomes of 2.1 & 2.2, how is the pupils' learning influenced by CT Dialogicity?

In stating the aims and steps of research (section 2.4), I referred to the plan of the study to generate data through two stages separated by a short training intervention (**TI**) to promote dialogic talk (see more details in next sections). Accordingly, the research questions are followed twice; through the first stage prior to the TI (section 5.5.4) and the second stage following the intervention. The first two questions of both aims (i.e. 1.1, 1.2 & 2.1, 2.2) are addressed through the analysis chapters (Ch. 6, 7, 8 & appendix 2). The last two questions from both aims (i.e. 1.3 & 2.3) are addressed in Chapter 9 that is devoted to establishing a synthesis of ideas, given that both summarise the findings of the study on its main purpose of *reflecting on and developing the concept of Dialogicity in characterising the nature of CT in relation to both teaching and learning* (refer to section 1.2).

The next section explains the research stance that guided the investigation of these questions.

5.2 Research stance

This research is guided by two major interrelated ‘influences’; the contribution of relevant literature on the researched issue on one hand, and the methodological directions suggested by educational research on the other.

The study looks to provide a rich and thick descriptive account of CT Dialogicity, which drives the research approach to be of a qualitative nature. The qualitative approach stands on an interpretive philosophical position that looks at “how the social world is interpreted, understood, experienced produced or constituted” based on “methods of analysis, explanation and argument building which involve understanding of complexity, detail and context” (Mason, 2002, p. 3); a position of investigation and analysis that meets the sociocultural as the main theoretical perspective underpinning this study (refer to section 2.1.3).

From the analysis standpoint, qualitative data can be quantified by counting the occurrence of qualitative acts for example; a recommended strategy to support the trustworthiness of qualitative research (see section 5.9.1). This goes in accordance with the framework design that reinforces the qualitative analysis of the talk by including some quantitative measures; similar to those featured in the systematic approach of discourse analysis in the sixties and before, as the literature review has revealed (refer to section 2.3.2).

One fundamental way to carry out qualitative research is by using the case study method. Cohn et al (2007) emphasised the strength of case study in reality, describing how it can “recognize the complexity and ‘embeddedness’ of social truths” (p. 256) by providing more than one lens to explore different contextual parts of the theme of the case. It is in this sense that it can be utilised to look for “the particular in context rather than the common or consistent, and the holistic rather than the cross-sectional” (Mason, 2002, p. 165). This

research takes CT as the case to be studied and investigated in relation to its Dialogicity. To ensure more than one lens to investigate CT, came the plan of following pupils' learning, which has been driven, meanwhile, by recommendations from literature (refer to section 2.1.1). Furthermore, the original plan of the study included the investigation of the teachers' and pupils' views of teaching and learning in general, and of the practice of CT specifically, for which data has been generated in fact. However, this data could not be analysed due to limited time. Although information regarding its sampling, research techniques and generation might give a more substantial account of the actual data generation, this information is left out from this chapter for the desire to not confuse the reader with unnecessary details (such information and early analysis of its data generated in the pilot phase can be found in the pilot study's report in appendix 5).

Planning the TI came also to reflect the two mentioned influences. On the one hand, it was driven by the literature's persistent finding that dialogic practice is usually under-represented in teaching. I believed that the intervention would result in more rich data by providing the Dialogic type of talk, which was expected in turn to lead to a more thorough analysis. On the other hand, this intervention represents another strategy to meet the case study requirement of more diverse investigation.

In short, this study is taking the qualitative approach to research and is utilising the case study method in which the focus does not lie on individuals (teachers or pupils), but on the social and cultural phenomenon of CT that these individuals perform.

5.3 Research design

The research stance regarding the aspects intended to be investigated as well as the TI, led to build the research design over two dimensions; descriptive and developmental (table 5.1).

	Aspect 1: CT Characteristics	Aspect 2: Pupils' Learning
Stage 1 <i>(Before Intervention)</i>	To characterise observed CT from the Dialogicity perspective (Aim 1), topic 1	To examine the pupils' learning and relate it to the CT characterisation (Aim 2), topic 1
Training Intervention		
Stage 2 <i>(After Intervention)</i>	To characterise observed CT from the Dialogicity perspective (Aim 1), topic 2	To examine the pupils' learning and relate it to the CT characterisation (Aim 2), topic 2

Table 5.1: Design of the study

The descriptive dimension relates to the two aspects of CT characteristics and pupils' learning, whereas the developmental dimension attends to the change in the two aspects over a TI. Consequently, the data generation goes in two directions, horizontally and

vertically. It moves horizontally between the two investigated aspects, and vertically between two stages over the TI. Moving vertically is meant to reveal the particularities of different types of CT, while moving horizontally is an attempt to provide a more holistic picture of the observed CT⁹.

Data along the two dimensions of this general design was generated through a number of research techniques, and was analysed using different methods. To help the reader to follow the rest of this chapter, I offer in what follows an overview of this design in relation to the research techniques and the method of analysis.

Characterising CT from the Dialogicity perspective has been carried out by:

- videotaping some science lessons in each stage;
- transcribing the CT;
- classifying it according to the communicative approach classes of talk;
- further characterising the Authoritative and Dialogic types of talk through a detailed discourse analysis using the analytical framework introduced in Chapter 3.

For the learning aspect, it endured a complex procedure of investigation. In section 2.1.3, I explained that in investigating the pupils' learning in this study, there will be the attempt to look into the pupils' understanding- reflecting the 'knowledge stuff' on the one hand, and following any indicators of the 'knowledge' or 'non-knowledge stuff' that the CT data and its analysis can provide on the other. Likewise, the study's second assumption set to define the position of CT in relation to teaching and learning, looks at learning as a process and as a product in relation to the CT as an act of teaching (refer to section 2.1.2). In view of this, pupils' learning was approached as follows:

- examine learning as a process by looking into the CT characterisation obtained from the application of the framework for general indicators of supporting/not supporting learning;
- examine learning as a product by looking into the pupils' understanding subsequent to the teaching, by utilising two research techniques; focus group discussion as a main technique and 'bubble dialogue' (sheets containing drawings of some scientific problems that the pupils need to offer their thoughts about) as a secondary technique.
- follow the results of the pupils' understanding back to the CT characterisation (see an overview of the study's approach to investigating learning in fig.9.6, section 9.2).

⁹ The original design of investigating the teachers' and pupils' views was meant to support this horizontal move to provide such a holistic picture.

Detailed clarification of the research techniques and method of analysis are explained in following sections. Nevertheless, there are three considerations that can explain the rationale behind the selection and the organisation of the three techniques of video recording, focus group, and bubble dialogue, as reflected by the above overview of the research design. These are:

- to meet the qualitative approach by video recording the observed teaching for its CT to be transcribed for a detailed discourse analysis, and engaging the pupils into interactive discussion to get to their ideas and thoughts.
- to follow a model of interaction (fig.5.1) proposed by Wall and Higgins (2006):

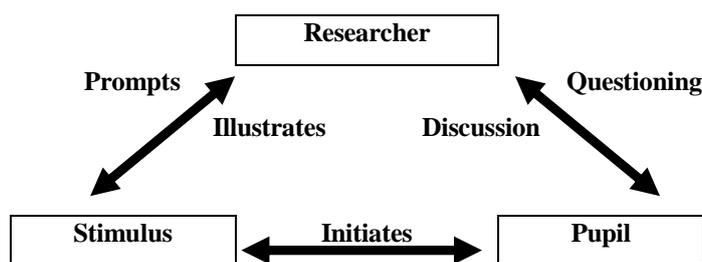


Figure 5.1: Model of Interaction by Wall and Higgins (2006, p. 42)

This model recommends the use of a stimulus to initiate and encourage the respondents' participation in discussion settings, such as interviews and focus groups. In investigating pupils' learning, the technique of bubble dialogue was used to represent the stimulus in the above model of interaction.

- to externalise the internalised thoughts of the participants using techniques that produce spoken and written data, and integrate them together in investigating the researched aspects. Vygotsky (1986, p. 218) argued that "thought is not merely expressed in words; it comes into existence through them" describing the relation between the two as "a process, a continual movement back and forth from thought to word and from word to thought". I thought that stimulating this movement and giving it time to go back and forth is a potential way to provide a lens on the individual's internalisation. The bubble dialogue as a stimulus for discussions is, meanwhile, allowing the participants to have the time to think about the issues to be discussed and to express this thinking on paper before talking about it through the focus group discussion.

Having established the research stance and design, I move now to explain the research methodology in fine detail.

5.4 Selection of participants

The study is based on theoretical (purposeful) sampling in which the selection of the participants is controlled by the needs of the study and its emerging analysis (Morse &

Richards, 2002, p. 74). It was also guided by feasibility issues concerning the empirical study's circumstances of time, distance and respondent availability for example (Dörnyei, 2007). These decisive factors appear through the following description of the sampling procedure:

Grade and scientific topics

Given the design of the study to investigate pupils' learning, the sample needed to be directed to specific scientific topics. Pupils' learning is followed in this study with the intention of linking it to CT Dialogicity. Hence, attention goes to the results on pupils' learning only in relation to the characteristics of the recorded CT. I intended to make no judgement on the pupils, the teachers or their pedagogy in general. Specifying certain scientific topics was needed then, only to help me as a researcher in preparing the related research techniques (sections 5.5.2 & 5.5.3) and planning the TI to include some information about the scientific topic of the second stage (section 5.5.4). No assumptions were made about the subject matter in relation to CT Dialogicity. Hence, the sample was open to any chosen topics. This offered a flexibility in selecting the grade and topics, to be made in accordance with the empirical study circumstances. Different practical considerations related to the Omani science curricula, the study's design, and early planning of the data generation time have specified the sample to grade nine in Cycle Two BE school (refer to section 4.1.3) where two scientific topics were selected to be observed:

- Stage one: Substance Changes in the Chemistry unit
- Stage two: Electric Circuits in the Physics unit

The sample requirement of the school, teachers and pupils was specified accordingly by the selected grade, i.e. grade nine.

Teachers and school

As has been explained previously, this study looks to further characterise Authoritative and Dialogic communicative approaches (section 2.4). This imposed the requirement to provide as much rich data as possible to ensure varied types of CT. It was decided then to look for a sample of good and experienced science teachers who are needed also to try more dialogic practices in response to the TI. This requirement of experienced teachers was reinforced by the outcomes of the pilot study in which one science teacher with one year's experience had participated (see more details in appendix 5). The observed teaching showed her highly dominating the talk verbally and intellectually; not offering hence CT data of varied types that would allow the study to meet its aims.

The sample requirement of experienced teachers was achieved by contacting the senior supervisor of science in the Internal Region of Oman (the researcher's region). Counting on

his department's evaluation, the senior supervisor recommended a number of female teachers as it is difficult, from a cultural point of view, to observe male teachers. Several teachers from different schools agreed to participate. The early practice of the pilot study revealed the disadvantage of selecting cases from different schools for fear of not being able to get the planned data. Due to cultural influences, the female teachers who agreed to participate did so under the condition that I would be the only one recording the videos and watching them for the analysis afterwards. It was not possible then for me, as one individual, to move between different schools to videotape the teaching. Schools of the same type (e.g. Cycle Two) in Oman are usually relatively far from each other. It is difficult therefore to control the time of the lessons that are planned to be videotaped, which might have caused loss of data. I was lucky to find three teachers in one school who are considered by their science supervisor as competent and co-operative. In this school, however, there were four science teachers of grade nine. The fourth teacher was evaluated as being a good teacher although not as qualified as the other three teachers. Thinking of strengthening the study and avoiding any emotional harm, the sample included the four teachers.

Pupils

The four teachers in the sample identified the classes to be observed. They informed the pupils in their classes of the study, and I talked to these classes afterwards to make sure that no one had a problem with being videotaped. One group of pupils (5-6 pupils) in each class was selected based on the teachers' recommendations¹⁰ to constitute the sample for examining the learning. After explaining to them the data generation process they will go through (see section 5.6.1) and ensuring some ethical considerations (see section 5.10), I sought the approval of every pupil in the group. Table 5.2 summarises the whole sample.

SCHOOL	GRADE	TOPIC	TEACHERS	PUPILS
One BE school, Interior region	Grade nine science class (4 classes)	1 st stage: Substance Changes 2 nd Stage: Electric Circuit	four female Omani science Teachers	four groups of pupils (each 5- 6)

Table 5.2: Sample of the study

5.5 Research techniques

This section provides a detailed account of each of the implemented research techniques, and the rationale for their implementation in this study. Although the TI was not used to generate data, I consider it a research technique because it is used to meet the requirement of the study of different types of CT by its planning to affect the data generated in the second stage, hence I include it in this section.

¹⁰ The teachers selected pupils of different attainment levels.

5.5.1 Classroom observation: video recording

This study aims to capture CT as it happens in the real situation. By analysing it afterwards, it aspires to give a descriptive account of the types of talk exchanged between the teacher and pupils in the selected cases. The complexity of CT as a human action that takes place in a social and cultural setting requires the classroom observation to utilise the video recording technique. It is not efficient to rely on written forms of observation, by which a certain systematic scheme is designed to help the researcher in recording data during the action itself. Video recordings do take place in an observational setting, but they can provide more rewards than written sheets of observation. Video recordings help the researcher to get access to the fine details of the talk by allowing him “to capture versions of conduct and interaction in everyday settings and subject them to repeated scrutiny using slow motion facilities” (Heath & Hindmarch, 2002, p. 103). They might be retained for replaying and reviewing and can be also summarised and transcribed (Morse & Richards, 2002). Moreover, video recordings provide a live version of the data that gives the opportunity to develop a database that can be used for different concerns and interests; “they are not simply tied to particular projects, specific approaches, or the interests of a particular researcher” (Heath & Hindmarch, 2002, p. 103). Videotaping the intended lessons in this study achieved many of the mentioned advantages; CT could be transcribed effectively by replaying the videos; the visual contextual features could be described and included in the talk transcription, and the talk recordings could be accessed repeatedly when judgments over the types of talk were uncertain.

However, in observational research in general, there is always the problem of the participants’ reactivity (Cohen et al., 2007). Video recording the teaching is expected to have an impact on the behaviour of the observed teachers and pupils. One of the ways to get around this problem is to stay around those who are to be observed long enough for them to get used to the observer (Fraenkel & Wallen, 2006). Visiting the participating teachers before starting the empirical study, talking to the pupils and taking their permission to be videotaped, being in the school for the whole working day during the time of the study, and most importantly having videotaped an average of 15 lessons in each class; all, I believe, have contributed to reducing the reactivity problem. In addition, the researcher still has the choice to exclude the data that s/he believes does not reflect a natural act, a decision that was made in this study prior to the data analysis (see section 5.7).

5.5.2 Bubble dialogue

Bubble dialogue (**Bd**) as a research technique has emerged primarily from the work of Bill O’Neill and Harry McMahon, presented in their paper; ‘Opening new windows with Bubble

dialogue’ (O’Neill & McMahon, 1991). They described this technique as an ethnographic research technique that can be used to capture dialogue. Its main idea is based on placing the respondents in a role play situation in which they have to think for the characters that they are playing, to create a dialogue. The idea was developed to offer a computer-based technique in which the researcher can take a ‘sideways look’ at his/her participants (Ravenscroft, Wegerif, & Hartley, 2007). Bd software provides a comic strip environment that can attract children and adults by combining pictures with speech and thought bubbles. When starting a Bd session, there will be a first screen that introduces the characters and the ‘prologue’ which is meant to provide the scenario of the session (fig. 5.2). Clicking the starting icon in this screen (at the right bottom) brings up both speech and think bubbles in the next screen in which the user can start a dialogue. Dialogue continues in successive screens as the characters (played by the participants) take turns to think, speak, or think and speak.

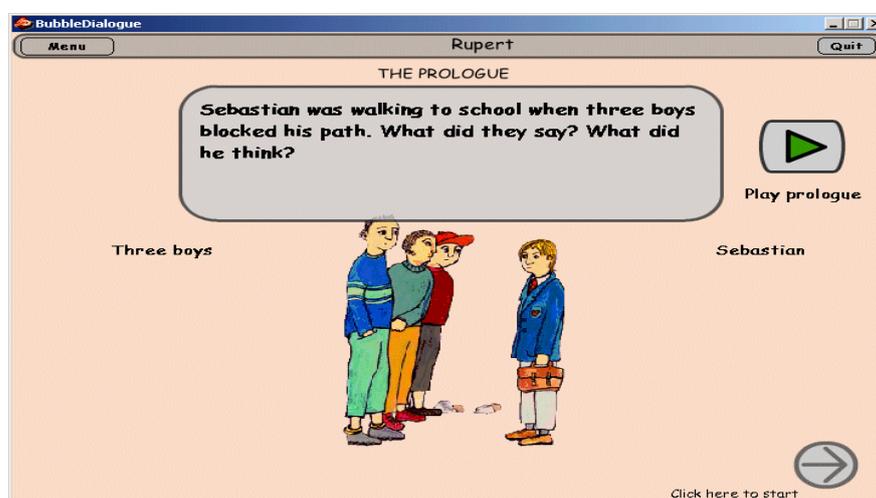


Figure 5.2: A first Bd screen (<http://www.dialogbox.org.uk/>)

After being introduced by O’Neill and McMahon (1991), this technique has been implemented by different researchers in different domains, providing evidence of its usefulness in “uncovering children’s attribution of meaning to social and cognitive experiences” (Ravenscroft et al, 2007, p. 33). However, O’Neill and McMahon (1991) themselves, have referred to a vital point that can affect greatly the validity of this technique. They noted that the “enfolding dialogue relates to the scene which, in turn, depends upon the choice of characters, the prologues and the backdrops” (p. 33). This reveals the difficulty of designing the scene of Bd sheets to be relevant to the intended aim, and the risk of creating a misleading dialogue at the same time. There is also the possibility of the written or uttered dialogue to extend to other themes than the planned one. Additionally, there will be always the difficulty of analysing and interpreting Bd transcripts. In this study, Bd was used as a secondary technique to investigate the pupils’ understanding. In the different studies that I came across (e.g. Jones & Issroff, 2005; Rajendran & Mitchell, 2000; Ravenscroft et al., 2007; Wall & Higgins, 2006; Wall, Higgins, & Smith, 2005; R.

Wegerif, 2006; R. Wegerif & Dawes, 2004), this technique was implemented to promote learning or to explore perceptions of learning (e.g. using ICT in learning). It has not been used, to the best of my knowledge, as a practical technique to elicit pupils' understanding of taught subject matter. Nevertheless, this goal is legitimated with the advantages of the Bd in helping pupils to express themselves and to externalise their thoughts by stimulating their thinking about the phenomenon using the presented scenes. By doing so, they are also given the chance to express their ideas and reflect on them using empty thinking and speech bubbles which give the impression that they need to be filled with dialogue (see fig.5.3). On the other hand, the difficulties of using Bd as a research technique, as mentioned before, are less likely to affect the validity of utilisation in exploring conceptual understanding. This is because designing the scene of conceptual or phenomenological exploration and interpreting its resulted dialogue are most likely to be agreed upon, as the theme here is not as complex, controversial and multifaceted as other themes concerning social and interpersonal aspects of learning that this technique has been commonly used to examine (e.g. looking into the feelings of pupils with special education needs).

Practically, there is no Arabic version of the Bd software to be used in this study. Nevertheless, this inconvenience could be avoided. The scenes of the Bd sheets, devoid only of the animation elements, were designed. Two scenes had been drawn for each of the two topics reflecting general scientific problems (see the example in fig.5.3 and the rest in appendix 3). Certainly these problems do not reflect all or most of the issues included in the curriculum for the two topics. However, having the main purpose of Bd sheets as to stimulate and guide the FG discussions (the main technique in getting to the pupils' conceptual understanding), offered flexibility in choosing these problems, as the FG discussions could be extended to other different issues based on the researcher's guidance and the pupils' argument (see section 5.6.2).

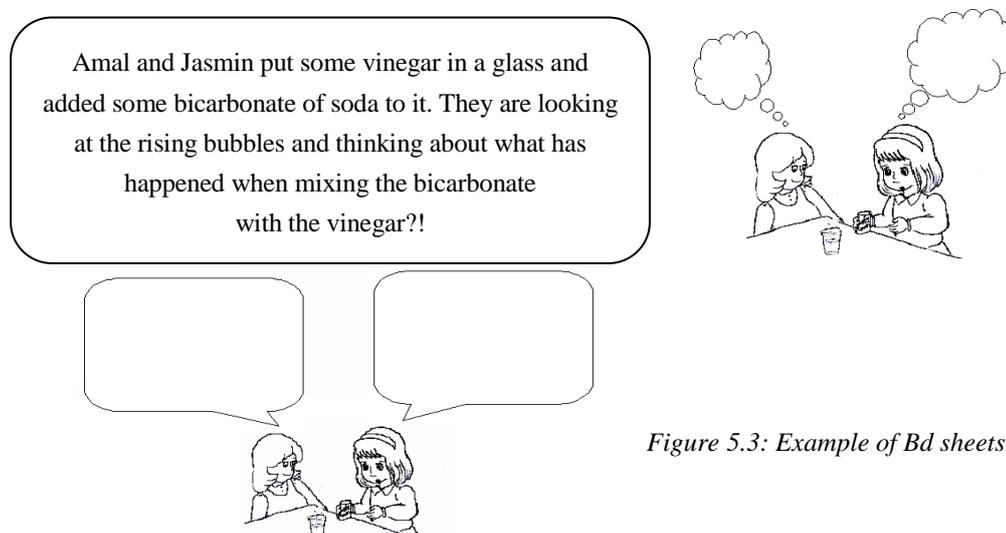


Figure 5.3: Example of Bd sheets of stage

The lack of animation affects the movement of dialogic turns between characters, but this was solved by providing multiple copies of the scene with different moves of speech bubbles between characters (fig.5.3). The participating group from each case at each stage was provided with Bd sheets and was given time to fill in the speech bubbles.

One of the aims of the pilot study was to investigate the reliability of the planned research techniques, among which was testing the Bd sheets *per se*, and in comparison to normal test questions (see examples of such questions in appendix 4), to:

- examine the appropriateness of the drawings in the Bd scenes
- compare the potential of the normal test questions and the Bd techniques in revealing the pupils' thoughts

The Bd technique proved to be more effective than the normal test questions. On the one hand, the written dialogue through speech bubbles seemed to reflect the pupils' thoughts more than the general answers for the normal questions. On the other hand, the scenes of the Bd sheets played a good role in stimulating the FG discussion. Nevertheless, the pupils' written dialogue to these sheets could not provide as detailed and rich data as required and as the FG discussion did.

5.5.3 Focus group

The FG as a method of data collection is associated usually with qualitative research settings. Parker and Tritter (2006) refer to the increasing popularity of this method among social scientists due to various reasons. They note that FG is “more adaptable to a range of research approaches and designs” and can generate “large amounts of qualitative data” (p. 23). The purposes of the FG have been described by Stewart et al (2007, p. 102) as to allow “an in-depth exploration of a topic about which little is known”, and by Krueger and Casey (2000, p. 3) as “not to infer but to understand, not to generalize but to determine the range, not to make statements about the population but to provide insights into how people perceived a situation”. In social sciences, the FG is considered as an informal group discussion where participants can express their views on the issues related to the discussed topic (Parker & Tritter, 2006; Stewart et al., 2007). Participants involved in this discussion are supposed to have something in common with each other and something that the researcher is interested in. In such an articulation, the FG can be confused with group interviews. However, Parker and Tritter (2006) argue that there is an important difference between the two which relates to the role of the researcher and his/her relationship to the researched. They make a distinction between the two scenarios, stating that in a group interview: “the researcher asks questions, the respondents relay their ‘answers’ back to the researcher”, while in FGs the “researcher plays the role of ‘facilitator’ or ‘moderator’” of

the discussion within the researched group (ibid, p. 26). Consequently, the inter-relationship of participants is the centre of the FG, where the centre of the group interview is the relationship between researcher and participants.

However, the group interaction cannot be guaranteed as participants might not be keen to engage with each other or might not be interested to talk about the discussed topic. It can be also dominated by a number of participants. Additionally, participants might start with expressing their individual views, but as the group discussion goes on, these views might change (Krueger & Casey, 2000). This would create hence a difficulty in analysing the data. This analysis, in fact, should examine the group interaction in addition to the substantive content of the discussion. This requires the researcher to pay attention to the “methods and (outcomes)” of participant recruitment (Parker & Tritter, 2006, p. 27). It also requires a precise recognition of what is to be analysed and how.

In this study, the FG as a research technique was used with the selected groups of pupils to look into their conceptual understanding, and was integrated with the research technique of Bd sheets following the model of interaction proposed by Wall and Higgins (2006) (section 5.3). Having the aim of examining the pupils’ understanding of the taught subject matter, specified two requirements, namely:

1. offering the pupils the chance to talk about their understanding. The pilot study proved that the pupils’ writings, whether answering test questions or filling in the Bd sheets, could not provide as detailed an account of their ideas as the FG discussion;
2. offering the pupils the chance to interact with each other, with the researcher just facilitating the discussion rather than controlling it. By doing so, more of the pupils’ thoughts were expected to externalise.

Both of these requirements point to the need for a FG rather than a group interview to get to the pupils’ conceptual understanding and difficulties. As clarified above, this research technique is criticised for not providing the required deep exploration due to its shortcomings in relation to stimulating interaction and generating/analysing data. The integration of the Bd sheets and the FG settings is an attempt to reduce the effects of these shortcomings. Planning the discussion of the FG around the data from the Bd sheets was expected to promote the group interaction and discussion. On the other hand, such integration was also intended to draw some kind of a border line for group discussion by having the visual sheets as the centre of this discussion through the whole period of the session. In fact, the pilot study had demonstrated the effectiveness of the Bd sheets and the FG ‘together’ in revealing the pupils’ thinking. It showed also that using recorded discussions of the participating group during the observed lessons (see section 5.6.2) is a potential technique for investigating the pupils’ developing understanding; a procedure that

was not taken into consideration before. Consequently, the three sources of data of classroom group discussions, Bd writings and FG interaction were used to investigate and follow the pupils' understanding in the analysis chapters (see sections 6.4, 7.4, 8.4 & 8.6).

5.5.4 Training intervention

The training intervention (TI) was designed to encourage the participating Omani science teachers to promote more dialogic talk in their teaching by addressing the importance of involving pupils' ideas and experiences in science learning, and how such ideas are to be incorporated through a dialogic form of teaching. Changing the quality of talk in the classroom necessitates change in professional practice. However, this change is not easy and requires effective training, adequate time and resources, support and cultural change (Keogh & Naylor, 2007). It cannot be assumed therefore that the short TI in this study would make a sustained difference in the professional practice of teachers, nor is this a main aim. Instead, this intervention was designed for the purpose of helping the teachers to try more dialogic practices, leading to generating data of different types of CT needed by this study. I believed that by engaging the teachers in the activities of this intervention, there would be an influence on their conceptualisation of CT, and by asking them to try more dialogic practice, there would be a change in their CT practice to a certain extent that would offer different type(s) of talk in the second stage subsequent to the intervention.

Different activities (e.g. questionnaire¹¹, handouts, presentations, group discussions) had been utilised in this intervention. It included activities that draw attention to the theme of students' prior knowledge and its influence on teaching and learning, to proceed by presenting the ideas of 'Learning demand' (Leach & Scott, 2002) and 'CA' (Mortimer & Scott, 2003) with a greater focus on dialogic talk. Overall, it included:

- Pre-Workshop tasks: students' prior knowledge
- Workshop 1: addressing students' prior knowledge in teaching
- Workshop 2: planning teaching towards more dialogic talk

A portfolio has been prepared in English (appendix 4), including for each workshop:

- A statement of aims
- List of contents
- An overview of the included activities with suggested timing
- Copies of the workshop materials (Arabic + English)

¹¹ The questionnaire aimed to reveal the pupils' misconceptions on general scientific issues, and its results were used only to convince the teachers that the pupils' prior ideas are strongly held and resistant to change, even after teaching. It is then part of the TI, but has nothing to do with the data of this study.

The limited space does not make it possible to include the TI portfolio and materials in this report. Nevertheless, table 5.3 offers a general summary of the TI activities.

1. Pre-workshop tasks	<ul style="list-style-type: none"> - distributing a questionnaire for all the pupils in the four participating classes, concerning some general documented misconceptions in science - handing the teachers the first part of a handout which explains about the pupils' prior ideas, and how it is important for the teaching to address them
2. First workshop	<ul style="list-style-type: none"> - discussing the findings from the questionnaire and relating them to the topics presented in the handout - conducting a presentation which moves in its content from the pupils' pre-ideas to the classroom interaction - displaying/discussing some examples of pupil-pupil talk- obtained from the case in the pilot study- that demonstrates different misconceptions and alternative ideas about the topic of 'substance changes' -handing the teacher's handout, part 2 to be discussed in the second workshop
3. Second workshop	<ul style="list-style-type: none"> - discussing the topics presented in the handout (part 2), focusing on the CA classes of talk and 'Learning Demand' ideas, and including some suggested teaching activities for the topic of 'electric circuit' that can be implemented to disclose the pupils' prior ideas - demonstrating/discussing the two teaching activities of "Big circuit" and "Rope loop" (related to the topic of electric circuit) - displaying examples of the four classes of the CA in addition to the ones presented in the handout - displaying/discussing examples of teacher-pupil talk obtained from the case in the pilot study in view of the CA classes - asking the teachers to classify different episodes of CT according to the CA classes of talk

Table 5.3: Summary of the TI activities

Certainly, all the materials had to be in Arabic. However, I first prepared the main materials in English (Questionnaire, Handout, Presentation), in addition to the portfolio itself. My supervisors were able to follow the content and the plan of the intervention and provided suggestions for development. Additionally, the outcomes from the pilot study contributed to some changes to the original plan. The pilot study aimed to:

- check the schedule of the TI; time, place and display details of the pre-workshop tasks and workshop activities;
- check the validity of the content and activities of the TI.

Reflecting on the piloting, the activities of the first workshop proved to be interesting, suitable and effective in highlighting the different issues concerning everyday/scientific languages and spontaneous/scientific concepts. The examples of pupil-pupil discussions from the observed lessons had reinforced, in fact, the significance of exploring such issues to look into their influence on teaching and learning science (see table 5.3). However, the second workshop was not as effective as the first one. From the researcher's evaluation and the teachers' reflections, this workshop appeared that it could possibly be improved by:

- displaying the teaching activities of Big circuit and Rope loop (see table 5.3) on screen and discussing them before and during the practical demonstration. The details of these activities had been presented in the handout which was handed to the

teachers long before the workshop. Assuming that all the teachers had read it understandably was not a sensible estimation from my side, and affected the progress of the workshop during the pilot phase. This was avoided in the main study;

- including some teaching episodes that show how the teacher can build the scientific view based on the pupils' ideas. The episodes that had been exhibited as examples of Dialogic talk could not show up the role of this type of talk in anything other than disclosing the pupils' preconceptions. The teachers had noted that they do use Dialogic talk in this sense through some practices. They are guided, for example, to evaluate the pupils' knowledge before and after each unit, and to adopt also the problem-solving approach, which require identifying pupils' views. The examples of the Omani pupils' talk in the first workshop had contributed to directing the teachers' attention seriously to the pupils' thinking. Likewise, the issue of the types of CT needed to be supported by some examples from Omani lessons. Demonstrating the dominance of Authoritative talk in some Omani science lessons was believed to emphasise more clearly what is meant by Dialogic talk and its importance. Such examples were displayed and discussed, consequently, in the main study;
- carrying out some activities where the participating teachers have to classify the different episodes of CT according to the CA classes of talk, which was performed in the main study;
- one of the defects of the second workshop was the authority of me as a researcher over the whole talk, which stands against the main goal of this workshop of calling attention to the meaning and the role of the Dialogic type of talk. I tried to avoid this in the main study.

These changes in the activities of the second workshop have contributed indeed to improving it during the main study. In fact, the overall intervention proved to be effective relatively as it has resulted in more practice of Dialogic talk in the second stage, as the results will show in next analysis chapters.

5.6 Data generation

Throughout the practical arrangements of the pilot study, it had become clearer that the main study was best conducted during the second semester of the schools' academic year because of the unstable circumstances of Omani schools at the beginning of the year, due to transfer of teachers between regions/schools, changing of timetable, unfamiliarity of the teachers with the classes they teach, and similar uncontrollable events. Accordingly, the main study was conducted during the second semester of the academic year 2007/2008. The whole process was started by contacting the Omani Ministry of Education in Oman to get

their permission to do the study in the Interior Region of the Sultanate during the academic year 2007/2008; a pilot study in the first semester and the main study in the second. While conducting the pilot study, I went on with looking for and contacting the teachers who are to participate in the main study (refer to section 5.3). As mentioned earlier, four teachers in a female second cycle school in the Interior Region of Oman had agreed to participate and kindly postponed the chemistry and the physics units to the second semester¹². Section 5.10.1 details the process of getting the consent of the Ministry and the participating schools, teachers and pupils in both pilot and main studies. The data generation for the main study began in early February and ended in late April, 2008. In the following subsection, this process is described in detail:

5.6.1 Meeting the participants

A few days prior to starting generating data, I visited the selected school. I was received by the senior teacher of science in the school who was also one of the potential participants and whom I was in contact with to arrange the empirical study. She was the one that had talked to the other three science teachers teaching grade nine, discussed with them the participation in my study, took their approval and informed me. She also decided with them to plan the teaching of the chemistry and physics units in the second semester, so their teaching of the two selected topics could be videotaped. Together, we met the headmistress of the school, and I made sure that she got the official permission letter to conduct the study in her school (see section 5.10.1). I also explained about the general plan of the empirical investigation to take place, including certainly the TI. She asked if other science teachers apart from the participating ones, and even herself, could attend the training. She did actually attend most of the first workshop, and so did other science teachers who also attended the second one.

I then met with the other three teachers in addition to the senior teacher, with the purposes of getting to know each other and explaining to them the procedures of the study, in addition to getting some general personal information from them (name, phone number, specialisation, years of experience) and having their written consent to participate and be videotaped. I took the timetables of all four and discussed with each one when to start recording the lessons on the topic of ‘substance changes’. I also took their permission to visit their participating classes accompanied by the senior teacher to talk to the pupils¹³. I did so with the purposes of introducing myself to the pupils, and making sure that no one minds the video recording, in addition to some practical benefits of getting myself

12 Under the new BE system, teachers decide about how to proceed with the curriculum throughout the academic year. Thus, the teacher might decide to start teaching the last unit in the curriculum at the beginning, or to put more time into one unit rather than another, and so on

13 At this stage, the pupils were already told about their classes’ potential involvement in a study through which they would be videotaped.

familiarised with the locations of the four different classes and the school laboratories. Furthermore, prior to the start of videotaping the teaching in each case, I was to meet the group of pupils selected to constitute the sample for investigating learning, and explain to them that: a) the video camera will be focusing on them during the teaching while having group discussion (see section 5.6.2), b) they will be given some kind of scientific problems to write their opinions about (i.e. Bd sheets), c) they will be having with me a discussion about those opinions after I get the chance to see their writings (i.e. FG discussion).

Later through the data generation process, I needed to introduce myself, and got in social contact with other staff members in the school like the laboratory technician (many of the videotaped lessons took place in the labs), the IT teacher (the training workshops took place in the learning resources room she supervises), other school teachers with whom I needed to sort out many incidents of time clashes between the lessons to be videotaped in different classes (see section 5.6.2), and administrative members with whom I needed to sort out the places in which the FG settings were to be conducted.

5.6.2 Generating the data

After meeting the participants and dealing with different practical issues, I started videotaping the teaching lessons of the first stage topic of ‘substance changes’; five lessons on average for each teacher, each lasting 40 minutes on average. In the classroom, there was one video camera held by me, moving in its shooting between the teacher and pupils according to the turns of talk. At the time of group discussions, the camera was focused on the selected group of pupils¹⁴. To be able to focus the camera on the group when needed, we (me and each teacher of each class) arranged for the group to sit at the back of the room where I could sit nearby and focus the camera on them in such a way that would not attract the attention of the whole class or disturb the teaching. Eventually though, I used to hand the camera to the group to place it still on their table, to record their talk but to be remain visually still at a certain viewpoint. I took the decision to do it like this because I thought that the group’ pupils were not feeling themselves, with me over their heads with the camera. This procedure appeared to work quite well for them. For the study’s sake, the camera captured the group talk quite clearly.

Following this, and whenever finishing the teaching of the topic in a certain case, the participating group of pupils were to be handed the two Bd sheets to fill, each with her own copies (section 5.5.2). On the following day, the group was to have the FG discussion, lasting for about 40 minutes on average. Prior to each session, I was looking into the pupils’

¹⁴ Under the new system of BE, the pupils are organised in groups instead of sitting individually, so the selected pupils were gathered in one group.

writings in the Bd sheets and used them afterwards during the sessions to stimulate and guide the discussion. For example, I would start with their ideas expressed in response to the scene in fig. 5.3 about the rise of bubbles, to move the discussion from there to other aspects of chemical change. Meanwhile though, the flow of the discussion was to be guided by their interaction and response to each other; the intended mode of discussion for which this technique was planned. If sharing similar understanding of a certain point, the girls were to support each other's answers and might provide more explanation. Alternatively, having different opinions was to stimulate usually a longer argument, in which case, the talk was to reveal the pupils' deeper thoughts and disclose different conceptual difficulties normal test questions would not be able probably to expose. The FG discussion did not go on ideally like this all the time, however. In fact, throughout these discussions, I used to challenge the pupils' expressed opinions to see how solid their understanding was, in addition to stimulating them to talk and answer me back, which also helped to reveal some misconceptions and conceptual difficulties. Certainly, some pupils were more confident than others while talking, expressing their thoughts and arguing. These pupils did contribute indeed to stimulating more interaction and sustaining argument on different occasions. On the other hand, there were the quiet pupils whom I tried to involve in the discussion by asking for their ideas or what they think of others' opinions. This study is interested in following the individual's understanding only to get deeper insights on pupils' learning in connection to the exchanged talk in the observed teaching. Overall, the FG settings worked quite well to provide such insights, as the analysis chapters will show.

The TI began after finishing with the data generation of the first stage. It started by distributing the questionnaire in the four participating classes of grade nine (see footnote 11). The teachers had the chance then to look into the pupils' responses. Previous to the first workshop, I also gave them the first part of the handout to read. Their comments on the questionnaire's results and the handout's topics made up the first activity of the first workshop, which took place in the learning resources room in the school. The rest of the first workshop activities went on, and in few days time, the second workshop was conducted. The two workshops went relatively as planned, as section 5.5.4 and the TI portfolio (appendix 4) explain. Each workshop lasted for about two hours. The administration and the senior science teacher worked together to specify the time of the two workshops and made the arrangement to free the participating teachers at those times, within the time range I asked for the workshops to be carried on. Other science teachers joined us when free. As pointed out before (section 5.6.1), the headmistress also attended most of the first workshop. However, the fourth participating teacher did not attend most of the second workshop. In fact, the data from this case has not been included in this study, as section 5.7 explains.

When the observed teachers finished the Chemistry and started with the Physics unit that includes the ‘electric circuit’ topic, the second stage started. The same procedures of the first stage were followed once again. However, more lessons were recorded for each case in this stage due to the many sub-topics that the topic of ‘electric circuit’ in the Omani curriculum includes. At that stage, in fact, I was not sure about the number of lessons I was going to use, but I decided to stop at a certain point in the teaching (Resistance issue) after recording eight to nine lessons for each case. Later on, the data was reduced as will be clarified in the next section. The empirical study ended by thanking all the participating teachers and pupils for their co-operation, help and support. Table 5.4 summarises the amount of the data generated for all the four cases, in view of the research aims (section 5.1).

	Case 1	Case 2	Case 3	Case 4	Sum
	Stage 1 (Substance Changes)				
Aim 1a ¹⁵	7 lessons	5 lessons	5 lessons	5 lessons	22 lessons
Aim 2a	10 Bd sheets, (5 pupils, 2 Bd sheets each) - I FG				
	Stage 2 (Electric Circuit)				
Aim 1b ¹⁶	9 lessons	9 lessons	8 lessons	8 lessons	34 lessons
Aim 2b	10 Bd sheets, (5 pupils, 2 Bd sheets each) - I FG				

Table 5.4: Generated data in relation to research questions

5.6.3 Hidden dynamics

Just behind the summarised scene of data generation in the section above, there were lots of details, practical arrangements, confusion, difficulties and challenges. It was a demanding process given moreover all the data that have been generated, including the excluded ones of the teachers’ and pupils’ views. Take the video shooting, for example; this procedure appeared to be very hectic and demanding given the amount of the lessons I, as one individual, had to videotape, and the clash between the lessons’ times in the four cases that I needed to sort out. One of the actions to cope with these challenges was to use two video cameras interchangeably, as one camera would not have enough memory and battery for the number of lessons I was videotaping each day. In some days actually, I had to video five to six lessons, for which I had to download the videoed lesson I had taken using a first camera to my computer, recharge this camera, and use the second camera to shoot other lessons, come back to the first camera and use it again after being recharged. In such chaotic situations, I had to do it fast so as not to miss or delay the next lesson to be videotaped. In one incident, for example, I terminated the download of a videotaped lesson (from case 3). Not realising that I had done so, I deleted that lesson from the memory of the camera to use

15 a: Before TI, Bd: Bubble dialogue, FG: Focus group

16 b: After TI

it to videotape another lesson. Therefore, I lost the video of that lesson forever. I learned from this experience to ensure a complete download of a lesson's video before deleting it from the memory of the camera. Similarly from other difficulties and 'mistakes', I learned different lessons and gained some experience, generally in:

- taking and dealing with visual data of video recording, and managing its technology;
- designing and interpreting visual data of the drawings of Bd scenes (and stimulus cards used in investigating the participants' views, pointed out in the pilot report);
- planning and performing teacher training through the TI;
- conducting FG discussions (and interviews in investigating the participants' views), and learning the limits of my role as a researcher in such settings;
- maintaining a balance between acting as a friend and as a researcher in the context of research.

Generally speaking however, despite difficulties and challenges, the data generation process was successful in terms of providing the planned kinds of data. However, it was a huge data set that could not all be used for analysis in this study. In addition to the excluded data of the teachers' and pupils' views mentioned at the beginning of this chapter (section 5.2), there was more data reduction needed, as the next section explains.

5.7 Data reduction

During the data generation process, I took an early decision to exclude the fourth case. In section 5.5.1 (about the video recording as a research technique), the participants' reactivity problem was raised, pointing to the possibility of the researcher excluding the data that exhibits it. In different incidents through her teaching of substance changes, the fourth teacher gave the impression that she was not acting naturally. For example, her emphasis on exchanging more talk with the pupils in incidents where attention seemed to be needed on practical activities was contributing to giving that impression. Later on, moreover, she had not showed much involvement in the TI; not going through her pupils' answers to the questionnaire, not reading the handouts and not even attending most of the second workshop. As she had not asked to withdraw from the study, I continued videotaping her lessons in the second stage and generating the other kinds of data exactly the same as with the other cases; however with a serious intention of not including her case in the analysis.

On the other hand, and given the huge data set that had been generated, I took the decision to start working with two cases only, planning though to go back to the third case later on. In fact, selecting two cases to start with, rather than one, was motivated by the curiosity to see different practices. I chose the second and the third cases, accordingly, because they seemed more interesting and offered, together, varied and rich data. I attended all the

lessons, and at that stage I could get a general idea about each teacher's performance. The second case looked interesting because a big change in her practice prior to and following the TI was obvious. The third case was different from all the cases because since the first stage, her practice was showing less authority and the pupils in her class were asking questions frequently. However, the level of detail that this study has followed made it clear that the third case could not be included, although I still think it would have offered valuable insights. Due to the same reason, the decision of excluding the investigation of the teachers and the pupils' views from the whole study was taken at that stage.

Furthermore, there was the thought at the beginning to characterise the entire CT including the pupil-pupil talk, so that data of group discussions had been generated. In addition to the video recorded group, there was actually an audio recording of two other groups in each class who were provided with audio-recording devices. Again, the limitation of space and time has resulted in focusing on the teacher-pupil talk only in performing the discourse analysis. Besides, eight to nine lessons were taken for each case in the second stage compared to five in the first stage. The recorded CT went through three stages of analysis (see section 5.8), with the second going deeply into characterising the talk using the analytical framework (Chapter 3). I decided therefore to reduce the eight to nine lessons to five to be analysed; a decision that is justified at the beginning of Chapter 7 (section 7.1). The next section describes the stages of analysis that the data of this study went through.

5.8 Data analysis

Most of the techniques implemented in this study produced video and audio recorded data. The first step in the analysis was to transfer the data from the media to text form by transcribing the recorded CT and FG discussions, including any non-verbal language that the videos show, and which I thought is important in explaining the context of the talk. As mentioned above, the data from the second and the third cases were the ones to be transcribed (section 5.7). The transcription was in Arabic. Through the analysis process, I had not translated all the transcribed data. Rather, translation from Arabic to English was done for episodes of CT when needed, as will be clarified through the following accounts on the data analysis. Regarding the translation itself, I have not followed any of the usual techniques of ensuring the validity of translation, such as using another person to do the translation and comparing the two afterwards. On the one hand, the translation of the exchanged talk cannot be done in isolation from the context, and it would be difficult for any other individual (even with a scientific background) to understand the context. On the other hand, the nature of this study is explorative and descriptive. It has not started with any hypotheses that need to be proved or disproved, and which would result in a bias of

translation, given especially the nature of the investigated talk. Nevertheless, I tried to do the translation as precisely as possible by seeking the opinion of Arab PhD TESOL students, using different sources including the internet and English textbooks to make sure of scientific terms, and getting critiques and suggestions of my supervisors when the translation looked odd.

There are three stages that the CT data analysis went through; surface, deep and synoptic analysis. Here is a descriptive account of each of the three, followed by a description of the analysis of the data from FG discussions:

5.8.1 Surface Analysis

This is the first stage of analysis that aimed to offer a descriptive quantitative outline of the CT in each case at each stage, by categorising it into the four classes defined by the CA of Mortimer and Scott (2003), and presenting the results in quantitative and graphical forms. This was done through the following steps:

1. After being transcribed, the talk (Teacher-to-Pupil & Pupil-to-Teacher CT) was divided into episodes according to its theme. Certainly, what is to be considered a theme is relative, so for example, a number of observations on a certain experiment can be seen together as one theme to be considered then as one episode. Alternatively, one can consider each observation as a theme according to which the episode would be defined. Nevertheless, this is not to be considered problematic as long as the whole exchange of talk around a certain issue is taken together, so to put it in one episode or more does not really make a difference.
2. Each episode was then divided into a number of excerpts, indicated usually by a breaking point in the talk (e.g. 'ok, let's move to the second question' or 'now, the observation in step x'), and has been characterised into the different classes of the CA (refer to section 3.1.2), whether 'Interactive/Authoritative' (I/A), 'Non-interactive/Authoritative' (NI/A), 'Interactive/Dialogic' (I/D) or 'Non-interactive/Dialogic' (NI/D). Time for each class throughout each episode was then calculated by going back to the videos and capturing the time between the beginning and the end of each labelled excerpt. Any time through which there was no exchange of talk, time of procedural talk (e.g. while giving instructions), time of group discussions or activities; the time of all such incidents were not included in the overall sum of teacher-pupil talk time.
3. Following this, the total time for each class throughout each lesson, and its percentage of the overall sum of teacher-pupil talk time in that lesson was calculated, and graphically represented.

The tables and the figure included in fig.5.4 (all named as fig.5.4) exemplify the three steps of the surface analysis of Lesson 4, Case 2, Stage 2:

Lesson 4 (time in minutes)					
Episode 1		Episode 2	Episode 3	Episode 4	Episode 5
I/D 1.59	I/D 2.56	NI/A 0.29	I/A 1.47	I/A 0.32	I/A 1.31
NI/A 0.55	NI/D 0.20	I/A 2.09	I/D 0.48	NI/A 0.47	NI/A 2.26
I/D 4.33	I/D 1.08	NI/A 0.29	I/A 1.05		I/A 0.54
NI/D 0.12		I/A 0.20	NI/A 1.13		NI/A 0.54
I/D 0.57		NI/A 0.45			
NI/D 0.19		I/A 0.16			
		NI/A 1.06			

Lesson 4 (time of teacher-pupil talk in each class)				
Class of talk	NI/A	I/A	I/D	NI/D
Time in minutes	9.04	8.34	12.21	0.51
Percentage	29 %	28 %	40 %	3 %

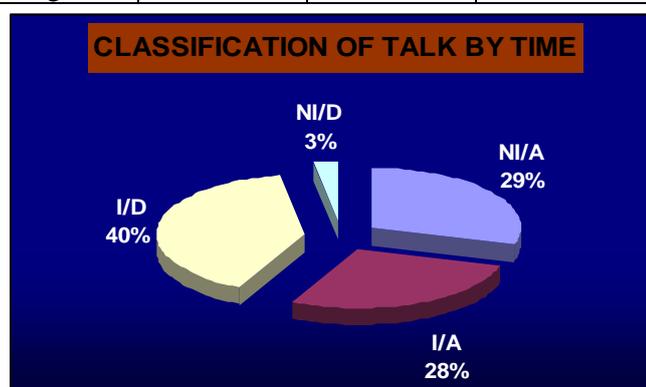


Figure 5.4: Example of 'surface analysis' steps

The general results from this analysis (second table and graphical representation) are offered for each case in its chapters of analysis. Following this surface analysis, examples of talk were selected from each lesson to go through the second stage of 'deep analysis'.

5.8.2 Deep Analysis

This is called a stage of deep analysis because the selected examples of CT were characterised in fine detail through the application of the analytical framework as presented, detailed and exemplified in Chapter 3. In selecting the excerpts to go through the deep analysis, a number of criteria were taken into consideration:

- A number of excerpts were selected from each lesson¹⁷;
- The selected excerpts were mostly reflecting all the classes of talk found in the named lesson, with more excerpts from the classes with higher percentage;
- When CT was dominated by a certain type of talk, Authoritative or Dialogic, the selection was based on choosing excerpts that look different in terms of the teacher's

¹⁷ Except lesson 2 of case 1, stage 1, because most of the talk time of this lesson was spent in stating the objectives, apparatus and steps of an experiment that was performed in the first stage (see sections 6.1 & 6.2). I decided not to apply the framework to any of this talk because it all looks the same and reflects similar characteristics of the examples analysed from the lesson before.

authority, the content of the talk (everyday/scientific-theoretical/empirical), the pupils' contribution, for example;

- the first stage was dominated by Authoritative type of talk. Hence attention was directed to select Dialogic excerpts from the second stage, as the study's aim to characterise the Authoritative and Dialogic types demands that the data reflect both types;
- *In fact, this aim itself gave the most important criteria in selecting the excerpts to be deeply analysed by the framework.* To get to the planned descriptive account of both types, the overall excerpts for a certain case from all the lessons and from the two stages all together were selected to provide, as a whole, as much rich data as possible, within the time allocated for this kind of analysis.

The selected excerpts were analysed in accordance with the four parts of the framework as explained in Chapter 3 (refer to section 3.2). All the analyses by the framework for the two cases are included in appendix 1, organised by the case and stage (e.g. Analysis by Framework, C1, S1). Having all the detailed analysis from both cases, I decided to try to put the results together to get to some kind of generalised issues, through the third stage named as the synoptic analysis.

5.8.3 Synoptic Analysis

In this final stage of analysis, there was coding of the results obtained from the application of the framework for each case in each stage using the 'NVivo7' software. In general, the coding was guided by the aims of the study of characterising both Authoritative and Dialogic types of talk and examining them in relation to pupils' learning, and by the 'elements' of the framework. Doing the coding was not a direct or a unidirectional process. Rather, there was a back and forth movement between the results to be coded on the one hand, and the issues arising from the coding on the other. Nevertheless, the coding can be summarised into three main steps:

1. It started with a 'topic coding' (Morse & Richards, 2002) of the results of those issues represented directly in the framework (parts 2 and 3), to result, for example, in the codes of:
 - The purpose of Authoritative talk
 - The content of Dialogic talk
 - The quantitative measure of evaluative follow-up in Authoritative talk
 - The quantitative measure of elaborative follow-up in Dialogic talk
2. A 'theme coding' (ibid) of the narrative account in the fourth part of the framework was performed then. In this type of coding, there was the attempt to reflect on the data, seek

patterns and develop categories that might help in developing more abstract ideas and themes. Accordingly, results were coded into certain themes (as they appear in the analysis chapters), some of which are:

- What has constituted Authoritative talk?
- What has influenced the level of Dialogic talk?
- How does the Dialogic talk seem to support/not support learning?

3. In each theme, there appeared a number of sub-themes that also needed to be analytically coded into sub-sub themes. For the theme of ‘What has constituted the Authoritative talk’, for example, the categorised sub-theme of ‘Dominance of the evaluative voice of the teacher’ appeared. Categorising the different modes in which this dominance has appeared constituted new sub-sub themes, as follows:

- 1 What has constituted the Authoritative talk?
 - 1.1 The dominance of the evaluative voice of the teacher, through the modes of:
 - 1.1.1 Initiation move
 - 1.1.2 Follow-up move

This process of ‘sub...themes’ categorisation was carried out for all the identified issues from the second step. It included a repeated exploration of the analysed excerpts of talk and a continual reflection in the light of the coded themes, and using the description provided by the application of the framework. This process has resulted in a detailed account on a number of issues considered to have arisen from the synoptic analysis. This means that all the ‘final’ issues presented in the chapters of analysis, although driven by the ‘elements’ of the applied framework, do originate from the data itself.

5.8.4 Analysis of focus group discussion

As qualitative data, the FG discussion also went through the coding process using the NVivo7 software. However, the coding here was more straightforward. As the purpose of the FG was to get to the pupils’ conceptual understanding of the taught subject matter in both stages, the codes were chosen in accordance with the main scientific conceptions included in the teaching. For the ‘substance changes’ topic in the first stage, for example, the pupils’ contributions to the discussions were coded for the themes and sub-themes of:

1. Characteristics of physical/chemical changes
 - 1.1 Change of external/internal features
 - 1.2 Formation/non-formation of new substance
 - 1.3 Reversibility/ir-reversibility
2. Evidence of chemical change

Furthermore, in using the FG discussion results to comment on the pupils' understanding, the data from the Bd sheets, the teacher-pupil talk and pupil-pupil discussions (when available) were all used in conjunction with the FG data. Under a section titled 'Commenting on the pupils' conceptual understanding' in each analysis chapter, there is:

- A presentation of the analysis of the FG data for each scientific issue;
- A presentation of the Bd data when available for the discussed scientific issue, and when it seems to enrich the FG data analysis;
- A presentation of pupil-pupil talk through the teaching (the participating group discussions), when available to enrich the presented analysis of the pupils' understanding;
- Use of teacher-pupil talk and pupil-pupil talk, when available, to trace the pupils' understanding- as indicated by the analysis from the above three steps- back to the teaching to examine how the teaching seems to have influenced it.

These different sources of data have been used, in fact, to triangulate the results of the pupils' developing understanding. The following section discusses such arrangements to triangulate the analysis and the other arrangements followed through this study to enhance its trustworthiness in general.

5.9 Trustworthiness of the study

In presenting their updated view of the 'Paradigm Positions on Selected Issues', Guba and Lincoln (2005, p. 196) refer to trustworthiness as the "Goodness or quality criteria" of Constructivism. Denzin and Lincoln (2005, p. 24) have been more specific in their description of the quality criteria of Constructivism stating that: "credibility, transferability, dependability and confirmability replace the usual positivist criteria of internal and external validity, reliability and objectivity". This view was initially proposed by Lincoln and Guba (1985) in their book; "Naturalistic Inquiry". They defined trustworthiness simply and clearly:

"how can an inquirer persuade his or her audiences (including self) that the findings of an inquiry are worth paying attention to, worth taking account of? What arguments can be mounted, what criteria invoked, what questions asked, that would be persuasive on this issue?" (ibid, 290).

They noted that the criteria of trustworthiness can be employed through different strategies and considerations. In describing the trustworthiness of this study, I rely on the two strategies of triangulation and thick description, and the consideration concerning the role of researcher. In addition, I consider that the trustworthiness of this study has been supported practically by the performance of the pilot study whose outcomes and implications actually helped to refine the "data collection plans with respect to both the content of the data and the procedures to be followed" (Yin, 2003, p. 79), as has been pointed out in different sections of this chapter.

Moreover, the explorative nature of this study can be considered a contributory factor to reinforcing its trustworthiness. Its main aim of characterising and describing CT Dialogicity, to develop the concept of Dialogicity itself as a theoretical perspective has freed the data analysis, to a large extent, from uncontrolled bias. Accordingly, the coding process was driven by the data, not biased by pre-determined established categorisation in the literature that might affect the reliability of the developed codes (refer to sections 5.8.2 & 5.8.3). Certainly, the analysis is influenced by the insights from the literature concerning the CT characteristics and pupils' learning, however the study was not directed to prove or disprove any hypothesis. The assumptions that define the position of CT in relation to both teaching and learning were established, only to guide the organisation and planning of this study with a neutral stance in assuming that learning will be influenced by teaching.

5.9.1 Triangulation

Triangulation is considered to be a way to strengthen the trustworthiness of qualitative case study research, as it aims to provide a deep understanding of the researched phenomenon (Denzin & Lincoln, 2005; Stake, 2005). Stake clarified that triangulation in qualitative research “has been generally considered as (a) process of using multiple perceptions to clarify meaning” (1998, p. 148), with the assumption that a certain observation or interpretation can be repeated. However, he argued that such an assumption of perfect repeatability is insensible, and in this way, triangulation can be viewed as to “clarify meaning by identifying different ways (of) the phenomenon being seen” (2005, p. 454). In this study, triangulation was approached in different ways. Although the account in this chapter can give some insight into these ways and their role in supporting the study's trustworthiness, their contribution is clearly evident in the following chapters. Nevertheless, I refer here to these ways briefly and broadly, for the reader to take notice and bear them in mind throughout the thesis.

Starting with the investigated issues, the study is looking into CT from different perspectives related to the broad issue of CT characteristics on one hand, and the pupils' learning in connection to the observed teaching on the other. The findings from both proved to provide a more detailed and substantial picture of the CT practice, and enriched the discussion on the issue of Dialogicity and related sub-issues. The trustworthiness is also supported by the multiplicity of the data generation techniques for each technique having produced indeed its own type of data: uttered (Videos & FG) or written (Bd), individually (Bd) or collectively (Videos & FG). Most importantly, the multiplicity of the data analysis methods and the depth with which this analysis was performed have resulted in providing different forms of evidence on some issues, and offered deeper insights in approaching others. Furthermore, although the data of only two out of four cases could be analysed for

the purpose of this study, the data from the two together has enriched the characterisation of the talk, and supported the findings on pupils' learning.

5.9.2 Thick description

Thick description has been described as a strategy for ensuring the criteria of dependability (Yin, 2003, p. 38) and transferability (Lincoln & Guba, 1985, pp. 316, 359). According to Cohen et al (2000, p. 311) thick description might involve “recording: speech acts, non verbal communication; description in low inference vocabulary; careful and frequent recording of the time and timing of events; the observer's comments that are placed into categories; detailed contextual data”. Lincoln and Guba (1985) argued that it is the inquirer's responsibility to provide a sufficient description of her/his case study that can “permit a person contemplating application in another receiving setting to make the needed comparisons of similarity” (p. 360).

As I am aware of the importance of this strategy in reinforcing the trustworthiness of my study, I do hope that all the information included in this report, in addition to those included in the appendices, provide sufficient details of the research process in this study. Yet I believe that deciding what constitutes a ‘good and relevant’ thick description is not easy, and can never be definite. I have attempted to clarify the constructs of this research to the extent that might enable others to replicate the study methodologically, i.e. to repeat, as closely as possible, its practice and procedures. This follows from Yin's (2003) advice while talking about the criteria in judging the quality of research: “The general way of approaching the reliability problem is to make as many steps as operational as possible” (p. 38).

5.9.3 Role of the researcher

Conducting a qualitative study is a challenging and demanding practice that necessitates the researcher to get qualified and to be committed to doing it. Morse and Richards wrote that “like any craft, qualitative research is best learned by doing it and talking about the experience” (2002, p. 8). Through the experience I got from piloting the techniques of this study, I came to realise how sensitive the role of researcher in qualitative research is. Throughout the different stages of generating data, analysing and interpreting them and reporting the results, I have been concerned with different queries regarding the trustworthiness and the morality aspects; how to do it?; Is it valid to do it like this?; Do I have the right to say or do so?...etc.

For example, in one incident during the pilot stage while videotaping the lessons, I interfered asking a group of pupils to keep to the discussion that they had already started regarding their contradictory views in relation to physical/chemical changes. The teacher

was far from encouraging the groups' discussion as she was not paying enough attention to the pupils' thinking. I wanted, however, to get a picture of the kind and the progression of group talk. These pupils' discussions appeared afterward as a potential technique to examine their developing understanding. After the pilot, I kept asking myself, though, if such interference is legitimate or not, and if the teacher's permission, in such a case, is sufficient to justify the decision. I have also confronted myself with enquiries about my position and role in guiding the FGs' discussions, having in mind Morse and Richards' argument about 'the researcher in the data', quoting their saying:

"Making data is not a passive process; rather, it is a cognitive process that requires tremendous investment on the part of the researcher. It requires extraordinary concentration, and it is the nature of questions asked and the attention that the researcher gives to the participants and to detail that determine the quality of the data collected" (ibid, p. 89)

On the other hand, cautions have been made in the literature regarding the possible negative influence of the researcher. Lincoln and Guba, for example, talk about the distortion arising from; "the inquirer's presence at the site", "the inquirer's involvement with the respondents" and "bias on the part of ... the inquirer" (1985, p. 282). Cohen et al (2007) have also referred to how the researcher might focus, in the analysis, on picking the more striking features and selecting only the evidence that supports her/his views, and to how s/he might depend on low-level data or results to generate a theory.

In my experience with conducting this study, especially during the pilot phase, I believe that I could not always preserve a neutral position during the intervention and the FG settings. It was also quite hard to divide my beliefs and views relating to the investigated topics, from the interpretation of data. However, having the nature of this study to describe the investigated phenomenon of CT Dialogicity, rather than proving/disproving any hypotheses, has eased my job as a researcher in freeing myself from any pre-determined beliefs and views through the generation and analysis of the data. Pole and Morrison (2003, p. 155) recommended that the researcher should act as a friend in the process of generating data, but s/he must position her/himself as a stranger while interpreting the generated data. Generally speaking, I have tried to apply this recommendation in performing the empirical investigation and analysing its data.

Ensuring relevant ethical issues does play a part also in enhancing the trustworthiness of the study, and relates to the role of the researcher. The next section describes generally the ethical issues that have been taken into consideration.

5.10 Ethical considerations

This section addresses some ethical considerations related to this study. Pointing out the issues of informed consent, anonymity of participants and confidentiality (Cohen et al.,

2007) reflects the concern of the study to get the participants' acceptance and protecting them from any possible mental or emotional harm.

5.10.1 Informed consent

In Oman, the process of getting approval for doing any educational research in schools should start with the Ministry of Education. In August 2007, I handed over the proposal of my study to the 'Technical Office of Studies and Development' in the Ministry; the department in charge of giving such approval. I got their permission to do the study in the Interior Region of the Sultanate during the academic year 2007/2008; a pilot study in the first semester (Sep-Jan) and the main study in the second semester (Feb-June). On its part, the office sent a letter of their official consent to the General Directorate of the Interior Region. I then asked the Region to send a copy of the official consent provided by the Ministry, firstly to the potential school participating in the pilot study and later on to the potential school participating in the main study, to let them know that their schools' participation has been approved by the responsible authorities.

In both studies, I took a written declaration from the selected teachers, after providing them with some details of the study (section 5.6.1), that they are willing to participate and agree to be videotaped. I, meanwhile, made it clear that they could withdraw from the study completely at any time, and that they could have access to any of the videos I take for each of them. At the end of the data generation process, one of the teachers asked for copies of her teaching videos. I responded by making copies of all the taken videos and handed each teacher her class videos.

Similarly, I took the permission of all the pupils in the potential cases to be video recorded and to answer the questionnaire included in the TI (section 5.5.4). For those groups of pupils selected by their teachers to constitute the sample to look into the learning aspect, I met each group from each class separately and explained to them that: a) they had been selected by their teachers; b) they are to go through the data generation process (refer to section 5.6.1); c) their answers and expressed opinions are not to be used in any sense as assessment of their attainment; rather they are to be used for the interest of my research only; d) their teachers will not have access to their answers and opinions unless they want to, and finally e) any of them could withdraw from the participating group at any time.

5.10.2 Anonymity of participants

All the participants - teachers and pupils in the pilot and the main study - were assured that they were not going to be identified by their real names in the published report of the study, using rather 'pseudonyms', described by Denscombe (2002, p. 181) as alternative and fictitious names to mask the true identity, to protect their identities and the identity of the

schools as well (I used letters and numbers as ‘pseudonyms’ as will be clear in the analysis chapters). I consider that the anonymity of the schools would not affect the credibility of the study sampling, given also that the details of the schools’ site and type are provided.

5.10.3 Confidentiality

The sources of this study’s data are largely based on video and audio recordings of Omani female teachers and the girl pupils in their classes. The teachers had agreed to participate under the condition that no one will be able to see the recordings other than me as a researcher. As I agreed to their condition, I have taken the responsibility of doing the transcription of all the media data without seeking assistance. I also assured the participants that the study does not aim to judge them in any sense, and promised to secure the data during and after the study, and use them for the purposes that serve the scientific research only.

In the piloting, I did take some episodes of the pupil-pupil talk, from the observed lessons and the recorded FG discussion, and used them to support the discussion in the first workshop after taking the permission of the participating teacher. This procedure had, in fact, a positive influence in stimulating the interest of the participants towards the pupils’ thinking and its relation to teaching and learning science. I could not, however, use episodes of the teacher-pupil talk to support the discussion in the second workshop as the teacher is known to her colleagues, which would contradict, ethically, the teacher’s trust in the confidentiality of the data. I believe, though, that as this teacher is aware and agreed to use the data for the purposes of research, it is legitimate, from an ethical point of view, that I used episodes from her teaching to support the intervention in the main study. In this case, certainly, the identity of the teacher was anonymous.

5.11 Summary

This chapter offered details of the research methodology; its design and implemented techniques, its data generation and stages of analysis, how the trustworthiness of the study is supported, and the ethical considerations that have been taken into account.

The next chapter and the two that follow present the results from the data analysis of cases one and two.

6 CHAPTER 6: ANALYSIS OF CASE ONE, STAGE ONE

This chapter includes the first section of data analysis. It examines the data of the *first case prior to the TI*, and begins with an account of the overall teaching approach of the analysed lessons (section 6.1). Then, it reveals the quantitative results obtained from the 'surface analysis' (6.2) and a detailed discussion about different issues arising from the 'synoptic analysis' (6.3). Finally, the results on the pupils' conceptual understanding obtained from the analysis of the focus group discussion are presented (6.4).

6.1 The overall teaching approach

The topic of 'substance changes' was taught in five lessons, with an average time of 40 minutes each. Two experiments were conducted as part of this teaching in the Omani curriculum. A considerable time was spent on preparing for and conducting these two experiments. Another significant portion of the lesson time was given to group work/discussion employed throughout the five lessons.

The teacher started the first lesson by introducing the topic and highlighting its importance before initiating the talk about physical and chemical features of matter and the differences between the two. The lesson continued with discussing the definitions and characteristics of physical and chemical changes and giving examples of each kind through teacher-pupil talk and group discussion.

Because of time limitations imposed by some school circumstances, the second lesson lasted only for 30 minutes. The teacher started the lesson by listening to the pupils' experiences regarding a famous cave in their region and, then, introduced the topic of the experimental activity about the changes happening in nature that lead to the formation of rocks. Most of the talk time of this lesson was spent on explaining the objectives, apparatus and steps of the first experiment using the textbook. A considerable time was devoid of teacher-to-pupil talk as the groups were examining the apparatus, designing the observation table and preparing for the experiment.

It is the third lesson when the experiment of studying the changes happening to rocks was conducted. Again, very little teacher-pupil talk took place as most of the lesson time was spent on doing the experiment (about 38 minutes). During the practical activity, the teacher was passing by the groups asking for their observations regarding the reactions and the results of each step. Sometimes, the teacher initiated talk to direct the pupils' attention to certain instructions on how to perform the experimental activity or to discuss observations or results.

Most of the fourth lesson was spent on discussing the results of each step in the experiment. For each step, there was a discussion of: what the step is about; what has been observed; what kind of substance change happened; and how to assign the observed change to that certain kind. The talk then included the formulae of the chemical substances involved in the reaction and the overall reaction equation. More focus was directed then to the criteria used for differentiating between the two salts of calcium carbonate and sodium chloride before applying some of the presented scientific information to the natural phenomenon of stalagmites and stalactites. After a group activity to answer written questions related to some drawings about the discussed phenomenon, the teacher exchanged quite a long talk about the fine details of the reactions leading to the formation of stalagmites and stalactites inside caves.

The final lesson started with revision of some of the applications of using acids in daily life and based on the way they have been used in the first experiment. Then, the teacher introduced the second experiment of the evidence (signs) of chemical change, and the talk continued with the explanation of its objectives, apparatus and steps. Different group discussions took place throughout the experiment. Afterwards, the teacher led the talk to discuss in detail the signs observed in each step. The lesson ended with revision of these signs and applying them to some other known reactions.

Table 6.1 reviews the content details of the five lessons.

Lesson	The content
1- Matter Changes	<i>Importance of studying matter changes - physical and chemical features of matter - definitions, characteristics and examples of chemical / physical changes</i>
2- Changes that cause the formation of rocks (1)	<i>Pupils' experiences regarding a famous cave in their region- the experimental activity about the changes happening in nature which lead to the formation of rocks; objectives, apparatus, steps and the table of observations</i>
3- Changes that cause the formation of rocks (2)	<i>Conducting the five steps of the experiment (putting sodium carbonate in a test tube and calcium chloride in another one, adding water to each one, mixing the two together, pouring the mixture through a filter paper to get a liquid and a precipitate, adding hydrochloric acid to the precipitate, evaporating the remaining liquid) - reactions and results of each step.</i>
4- Changes that cause the formation of rocks (2)	<i>The kind of change in the 5 steps of the experiment - the nature of the remaining substances in the last two steps and the criteria used for differentiating between them - the presence of calcium carbonate in rocks - the reactions leading to the formation of stalagmites and stalactites inside caves</i>
5- Possible evidence (signs) of chemical change	<i>The signs of chemical change (change in temperature, change in colour, gas rising or formation of bubbles, formation of precipitate) – the second experiment (adding some water to red phenol and calcium chloride and observing the temperature, adding sodium bicarbonate to the mixture and observing the temperature again) - observations and results from the experiment - other examples of chemical changes and the evidence supporting their kind.</i>

Table 6.1: Descriptions of lessons in C1, S1

6.2 Results from the ‘Surface Analysis’

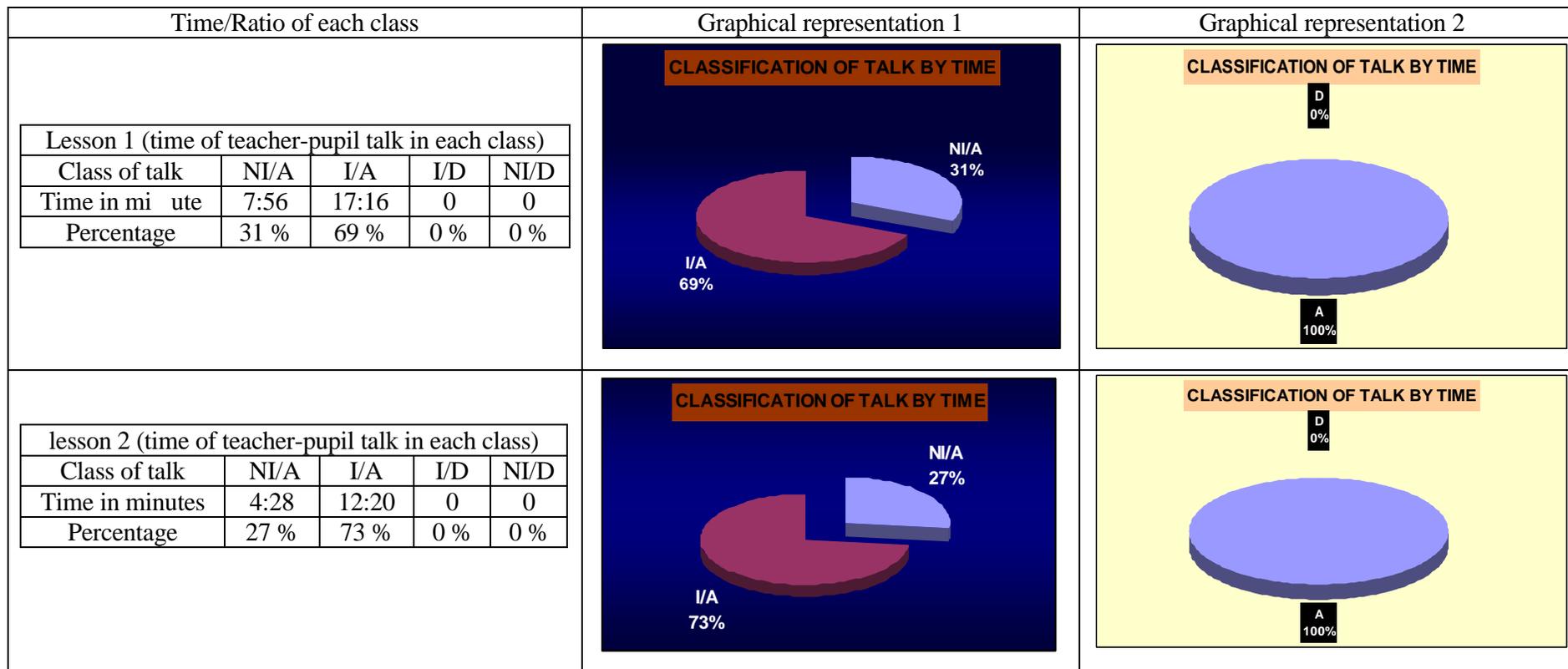
This section addresses the following RQ (refer to section 5.1) prior to the TI (a):

1.1a What classes of communicative approach does the recorded CT exhibit?

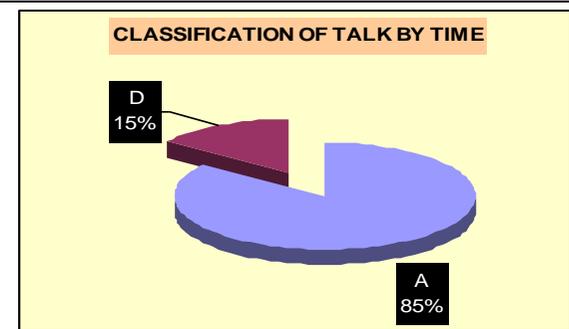
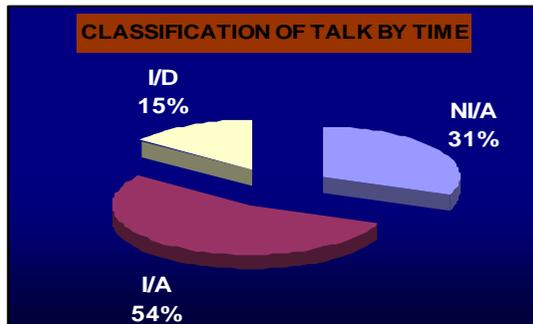
The entire CT analysed in this stage is a 'teacher-to-pupil' type of talk as the recorded teaching practice was devoid of any talk initiated by pupils. The classification of this talk into the four classes of the CA demonstrates the dominance of the Authoritative approach. Apart from 55 seconds of Interactive/Dialogic talk taking place in lesson three, the CT time (refer to section 5.8.1) has all been spent through Interactive and Non-Interactive Authoritative talk. Figure 6.1 offers a review of the results from each lesson including:

1. The Sum of time and ratio of each class of talk observed during each lesson;
2. Graphical representation (1) of the ratios of all observed classes of talk;
3. Graphical representation (2) of the ratios of Authoritative and Dialogic types.

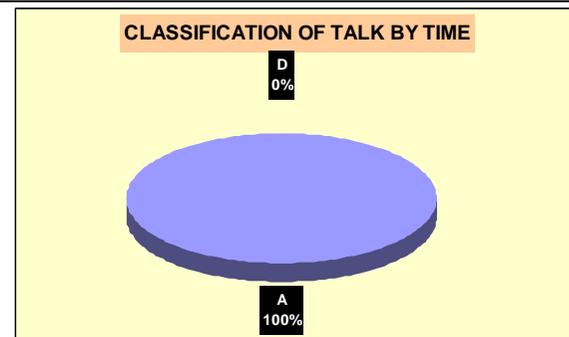
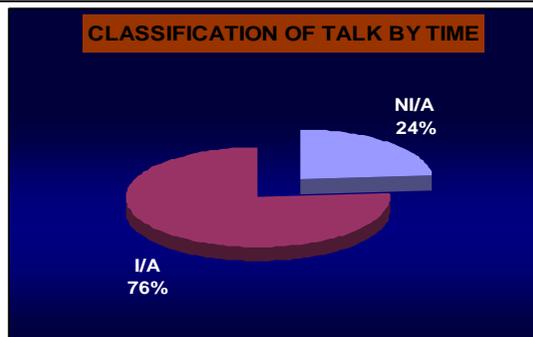
Figure 6.1: The 'surface analysis' results of C1, S1



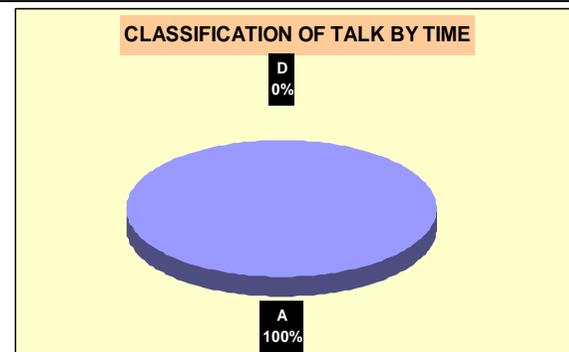
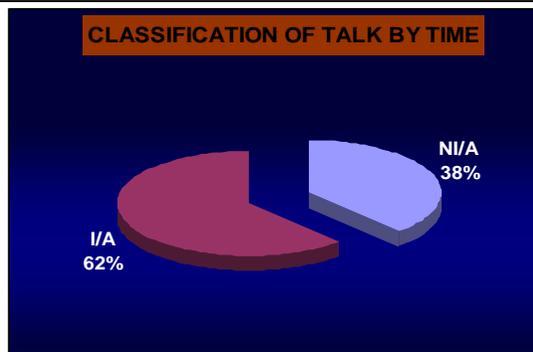
Lesson 3 (time of teacher-pupil talk in each class)				
Class of talk	NI/A	I/A	I/D	NI/D
Time in minutes	1:55	3:20	0:55	0
Percentage	31 %	54 %	15 %	0 %



Lesson 4 (time of teacher-pupil talk in each class)				
Class of talk	NI/A	I/A	I/D	NI/D
Time in minutes	7:14	23:16	0	0
Percentage	24 %	76 %	0 %	0 %



Lesson 5 (time of teacher-pupil talk in each class)				
Class of talk	NI/A	I/A	I/D	NI/D
Time in minutes	10:02	16:18	0	0
Percentage	38 %	62 %	0 %	0 %



6.3 Issues arising from the 'Synoptic Analysis'

This section addresses the following RQs (refer to section 5.1), prior to the TI (a):

1.2a What features of Authoritative and Dialogic communicative approaches are revealed by the implementation of the analytical framework?

2.1a What indicators of the potential of Authoritative and Dialogic communicative approaches to support pupils' learning are revealed by the implementation of the analytical framework?

As the results of the surface analysis illustrate (6.2), nearly the entire CT during this first stage was of Authoritative type whether Interactive or Non-Interactive. However, the varied examples of the Interactive approaches appear to show different authoritative levels. Through the 'deep analysis', certain features in characterising the Authoritative talk have emerged. These features looked less persistent and less evident in some examples than in others, and this was the point that brought the idea of difference in authoritative level into consideration. Overall, coding the results obtained from the application of the framework has resulted in three main issues that the Authoritative talk can be characterised in detail through. These are:

- What has constituted the Authoritative talk? (RQ 1.2a);
- What has influenced the level of the Authoritative talk? (RQ 1.2a);
- How does the Authoritative talk seem to support/not support pupils' learning? (RQ 2.1a)

In this section, these three issues are investigated and discussed in the light of the different examples of talk that have been analysed using the framework.

6.3.1 What has constituted the Authoritative talk?

The detailed analysis of different examples of talk reveals some general characteristics of the Authoritative type that have been noticed repeatedly. These are:

6.3.1.1 The dominance of the evaluative voice of the teacher

The evaluative voice of the teacher in the exemplified episodes of talk was found to be always there, and appeared through different modes of:

a) The follow-up moves: The teacher was giving an immediate evaluation for the pupils' contributions; approving the ones considered by her as scientifically correct and disapproving the ones she considered incorrect. This resulted in a continuous recurrence of the evaluative follow-up moves through the patterns of discourse. Whether approving or disapproving the pupils' responses, the teacher's authoritative voice emerged in her firm, strong and direct evaluation as demonstrated by different examples, some of which are:

R: The colour / F: The colour, good¹⁸

R: Melting / F: Instead of melting, I say melting point (Les.1, Ex.1)¹⁹

R: The dissolving of salt in water / F: That's right

R: Burning of candles / F: We don't say burning, we call it melting of candles (Les.1, Ex.2)

This evaluation was not confined to the words of agreement and disagreement only but it also revealed itself through the teacher's reactions in the form of intonations and body gestures. In many cases, she did not approve or disapprove the uttered answers explicitly. She just repeated those answers with an affirming intonation (^) indicating her agreement and a wonder tone (!) for disagreement. This can be noticed in most of the examples of this stage; some of which are:

S₃: Geometry... / T: The Geometry ^

S₄: Burning? / T: Burning?! Is there a burning degree?! (Les.1, Ex.1)

S₁: Calcium chloride / T: With calcium chloride^ (Teacher Writes the answer on board)

S₁: That a precipitate, It's sodium chloride /

T: Sodium chloride is a precipitate?! (Les.4, Ex.2)

S₆: The change of colour / T: The colour changed ^

S₅: The rising of bubbles / T: Bubbles rose?! (Les.5, Ex.2)

As the tones of the teacher's replies manifested the evaluative voice, so did her body language. An interesting gesture is the movement of the teacher's writing hand in relation to the board. In the aforementioned short excerpt from lesson four, for example, the teacher was approving the correct answer by repeating it with an affirming tone and writing it on the board. For the incorrect response, she was not just repeating it with the wonder tone pointed out previously, but she was also holding her hand away from the board. This was an indication from the teacher's side that the uttered answer is not the correct one to be documented on the board and, consequently, a signal for the pupil to change her answer.

b) The pattern of (I-R-E_v) sequence: The teacher's continuous evaluation of pupils' responses manifested itself in a continuous replication of the conventional sequence of Authoritative talk (I-R-E_v) throughout the patterns of discourse. This can be easily noticed if we try to divide those patterns into repeated chunks of the (I-R-E_v) sequence in the process of assigning every response to the original initiation. Most of the examples of this stage show this feature, and it is striking to see the persistence of this sequence through long episodes of talk, as the following patterns illustrate:

I-R_{1.1}-E_v-R_{1.2}-E_v-I-R₂-E_v-R₃-E_v-R₄-E_v-R₅-E_v-R_{6.1}-E_v-R_{6.2}-E_v-I-R_g-E_v-I-R₇-E_v (Les.1, Ex.2)

I-R_{1.1}-I-R_{1.2}-E_v-I-R_{1.3}-E_v-I-R_{1.4}-E_v-R_{1.5}-E_v-I-R_{1.6}-E_v... (Les.4, Ex.2)

c) The Initiation move: It is interesting to find that in some incidents, the teacher used the questions of the initiation move to practise the evaluative role. It happened that after some

18 R: Response , F: Follow-up , I:Initiation

19 Les.1, Ex.1: Example 1 in Lesson 1, and so on (refer to appendix 1)

initiations had been answered, and their answers were being evaluated, the teacher was repeating the same question. At other times, she was rephrasing the posed question by approaching it from a different angle. Through both strategies, the teacher aimed not to affirm the uttered answer directly through the follow-up evaluation but indirectly by stimulating the pupils to utter it again. These strategies can be demonstrated by short excerpts from the lesson four:

25.T	In the glass, But still you've not proved why it's physical change? Yeah S ₇	F I
26.S ₇	Cos the precipitate in the filter paper can be returned back to the glass #	R _{7.1}
27.T	Very good, cos I can reverse the step and I'll get the same previous result. So, it's a physical change, why? One of you say it again	F I
28.S ₈	Cos the precipitate can be returned back to its original state	R _{8.1}

Here, the teacher asked for a justification through the initiation in turn 25, got a response, and evaluated it positively in turn 27. In the same turn, however, she repeats the question again to get the same answer. Therefore, the initiation in turn 27 can be considered part of her evaluative voice.

14.S ₃	The formation of a precipitate during the work	R ₃
15.T	Yeah, that's good. The formation of a precipitate or a white substance - was before, at the beginning, then what? what happens to it?	F I
16.S ₄	It goes down	R ₄
17.T	It goes down bit by bit. If you have left it for a period of what? Of time then a white precipitate formed.	F

Here, S₃ provided the formation of a precipitate as an observed sign of chemical change in turn 14. The teacher appraised it in turn 15 but she initiated another question asking about what has exactly happened. She posed this question because she wanted to affirm the observation that S₃ had talked about, by getting further description of it. Again, the initiation, here, has been implemented as part of the evaluative voice. (see more examples on the two strategies in Les.3, Ex.3).

6.3.1.2 The movement of the talk towards what is considered the scientific view

The dominance of the evaluative follow-up move over the teacher's reaction to the pupils' responses indicates that the teacher was aiming to move the talk only towards the scientific point of view. Again, the restriction of the talk to this desired direction has not only appeared through the evaluative follow-up moves but also via other modes:

a) Using the initiation move: To direct the talk towards the scientific view, the teacher used the initiation move in different ways. In the first lesson, for example, while trying to extract the answer of 'boiling point' from the pupils, she used the initiation move to ask directly and repeatedly about this feature (see turns 7, 9 and 15 below) and ended with providing herself the desired answer when the pupils failed to do so (turn17):

7.T	...With the melting point, I can add something, what?	I
8.S ₄	Freezing point	R _{4.1}

9.T	Melting point is the same as freezing point, but there is another degree also considered to be a physical property...	F I...
15.T	... but we said the melting degree, what else can we say with? S ₇	...I
16.S ₇	The pressure?	R ₇
17.T	What is this pressure?! () What can I say with the melting point? (No answer) The boiling point. With melting, boiling point is considered as ...	F I R _T

In other examples, the teacher implemented another strategy of using the initiation move to direct the talk towards the scientific view. In the third example from lesson three, the teacher used the questions related to empirical content to ask 'Did certain observations happen' rather than 'What happened'. Such questions had imposed responses of the type of 'Yes/No' and the 'One from two choices' answers:

- I: Did...(it) dissolve? / R: No
 I: Have you noticed...colour? / R: No
 I: This ...didn't dissolve,...(that), was how before? / R: Dissolved
 I: ...Rough or Soft? / R: Rough

This illustrates that by restricting the pupils' answers to highly-defined alternatives through very close-ended questions, the teacher was not just leading the talk towards the scientific views, but towards highly-defined ones in fact.

b) Using the follow-up move: Although in some examples, the initial questions were open to different possibilities, still the teacher's manner of moving the talk towards the scientific account can be demonstrated by her follow-ups to pupils' responses. In a distinctive example (Les.3, Ex.2), the teacher initiated a question that is open to different assumptions. She asked the pupils to hypothesise the possible sources of error that might justify the failure of the filtration process:

1.T	...What's the reason or what are the errors?	I
2. S ₁	Maybe the way we put the filter paper is wrong	R ₁
3.T	Good, maybe you didn't put the filter paper in the right way, S ₂	F
4. S ₂	The filter paper hasn't been folded in a right way	R ₂
5.T	Yeaah, folding the filter paper in the wrong way, what else? S ₃	F, I
6. S ₃	Maybe the shaking of the solution?	R ₃
7.T	It does nothing with the shaking. Even after the shaking, the solution separates, ha? During the pouring of the solution, I mean when you poured it, maybe you did it quickly and some leaked out at the back of the filter paper and I said pour it slowly. So what do you do in this case? - I will repeat the step of the filtration again...	F

Although the teacher might have had some sources of error in her mind, the nature of the question has not allowed pupils' contributions to head for certain scientific views. Instead, there were different contributions from the pupils that the teacher might have not thought about. However, the teacher's contributions are the ones which were restricted to the scientific view. She used the follow-up moves to set the scientific direction. She did this by:

- Firstly: evaluating the pupils' contributions; approving the ones she considered to be correct scientifically (turns 3 & 5) and disapproving the ones she considered incorrect scientifically (turn 7);

- Secondly: not elaborating the pupils' responses, neither the correct nor the incorrect ones (I-R₁-E_v-R₂-E_v-R₃-E_v). She did not try to explore the pupils' thoughts about the sources they offered; why did they think about those sources and how did those sources affect the filtration process;
- Finally: having one specific error in her mind (see turn 7). Therefore, she asked the groups to repeat the filtration process by paying attention to that particular error and neglecting the ones offered by the pupils.

6.3.1.3 The absence of the neutral and the challenging voices of the teacher

The absence of comments and elaborative follow-ups from the talk has been widely noticed in the examples of this stage. For most of the questions, the teacher was evaluating the pupils' responses instantly without showing a neutral reaction that could give the pupils a chance to think about the presented answers or might have encouraged them to doubt those answers and offer different ones. Moreover, the talk had rarely witnessed the teacher asking pupils elaborative questions of 'how' and 'why'. The quantitative representation of the types of follow-ups in part three of the framework illustrates this feature. Table 6.2 demonstrates the dominance of the evaluative moves against the almost absence of the comments and elaborative follow-ups:

Examples of Authoritative talk	Types of follow-up			Examples of Authoritative talk	Types of follow-up		
	E _v	C ₀	E _L		E _v	C ₀	E _L
Les.1, Auth.1	9			Les.4, Auth.2	8		
Les.1, Auth.2	10			Les.4, Auth.3	10		
Les.3, Auth.1	3			Les.5, Auth.1	3		
Les.3, Auth.2	4			Les.5, Auth.2	2	2	
Les.4, Auth.1	11		3	Les.5, Auth.3	2	1	

Table 6.2: Comparison between F types in I/A excerpts, C1, S1

Authoritative talk can be directed to the scientific view through which the pupils' responses are evaluated but the teacher can still elaborate the pupils' answers or provide neutral comments before evaluating them. However, the high control of the teacher in many examples here has appeared and resulted in the lack of justification questions. In lesson four, for example, she initiated the talk to explain the natural phenomenon of stalactites and stalagmites as an application of the information presented in the previous lessons. During this talk, she asked a question of a high cognitive level about the substance forming as a result of the reaction of calcium carbonate with acid rain (Les.4, Ex.3):

13.T	Anyone know the name of this substance? ...as a result of the reaction of the calcium carbonate with the acid	I
14.S ₅	Potassium chloride	R ₅
15.T	We're saying calcium and she is going to potassium chloride. Of course no, cos we're talking about something with calcium. S ₆	F
16.S ₆	Calcium chloride	R ₆
17.T	No	F
18.S ₅	Sodium chloride	R ₇

19.T	Why sodium? Have we mentioned anything about sodium? Have we mentioned potassium?	F
21.S ₈	Calcium nitrates (T is nodding no)	R ₈ , F
22.S ₉	Calcium bicarbonate	R ₉
23.T	Calcium bicarbonate. Excellent, listen to her. The substance forming here is calcium bicarbonate...	F

The excerpt shows four pupils trying to guess an answer to the question posed by the teacher but they fail to provide the correct one. When S₉ offered the answer of calcium bicarbonate, the teacher got excited and approved it instantly and strongly. However, she did not try to elaborate it. She did not ask S₉ for any explanation that could reveal her thoughts about this answer, which is extremely difficult to be imagined as a guess. It may be interesting to mention that the chemical equation that represents the discussed reaction is not a simple one and the class has also not learnt it before. The absence of the elaborative move here has resulted in the absence of a justification from S₉ and, therefore, a possible clarification of her intellectual thoughts about it. Resultantly, it became impossible to infer the cognitive level of S₉'s response. The originality of the answer in this context was the only criterion to infer its high quality (refer to section 3.1.1)

The same difficulty of inferring the quality level of the pupils' responses also appeared in other lessons because of the absence of the elaborative voice of the teacher. In lesson one, for example, the teacher listened to many responses to her question about physical properties but she did not try to diagnose the pupils' thinking about the properties they offered. For example, when two pupils talked about the geometry and the density of the substance as physical properties (turns 6 & 12), the teacher did not elaborate them although both needed to be clarified, not only in the terms of their meanings, but also in the terms of the justification behind perceiving them as physical properties (Les.1, Ex.1):

6. S ₃	Geometry of the substance	R ₃
7.T	The geometry, we can see the geometrical dimensions (B), the geometry of the substance or we can see the outward shape.	F
12. S ₅	Density	R ₅
13.T	The substance's density, good. What else? S ₆	F I

Again, the judgment over their quality level was made based on their uniqueness in their context. In short, because of the absence of explanations from pupils of what they mean by and why they chose their answers, the judgment over the quality of these answers is open to question.

6.3.1.4 The verbal and the intellectual control of the teacher over the explanation task

A significant reason for the absence of the elaborative voice of the teacher, as mentioned in the previous section (6.3.1.3), is the teacher's control over the explanation task. As explained earlier in most of the examples, the teacher had restricted pupils' role to offering

mere possibilities while answering a certain question by not asking them for the explanations of or justifications for their answers. She saved this role for herself; explaining some answers and/or raising controversial issues about others. The teacher was playing this role, in fact, through two approaches of employing:

a) The follow-up move: the teacher practised control over the explanation task in some incidents through follow-up turns within the Interactive/Authoritative parts. Let us look, for example, at the pupils' responses and the teacher's reaction to them in the following excerpt (Les.1, Ex.1):

2. S ₁	The colour
3.T	The colour, good. But we need to pay attention to something here. Right, colour is a physical property but also can be? Chemical property. So I wouldn't take it now as a distinctive one, Ok? S ₂
4. S ₂	We can say melting
5.T	Instead of saying melting, I say melting point. It's a physical property, why? Well done (B). I mean girls if the substance was melting and then went through a freezing phase. Can't be returned back to its first state? Yeah it's possible, you get it? S ₃
6. S ₃	Geometry of the substance
7.T	The geometry, we can say the geometrical dimensions (B), the geometry of the substance or we can say the outward shape.

Here, three pupils provided different answers in turns 2, 4 & 6. The teacher reacted to these answers by explaining what is meant by geometry in turn 7, justifying why the melting point relates to physical properties in turn 5 and raising doubt about the colour as a physical property in turn 3. In such reactions, the teacher was holding verbal control over the explanation task. This resulted in long turns for the teacher and short ones for the pupils. Through these long verbal turns, she was also controlling the talk intellectually by directing the thinking of the individuals. Thus, she not only disallowed the pupils to speak out their own thoughts, but she also imposed her own ideas on their thinking.

b) The Non-Interactive communicative approaches: the teacher also used Non-Interactive/Authoritative approaches in many examples to lecture about the points of views raised through the Interactive talk. This can be illustrated by the purposes of 6 out of 8 examples of Non-Interactive Authoritative (NI/A) talk that have been analysed using the framework (table 6.3):

Example of NI/A talk	Purpose of the talk
1. NI/A, Les.1, Ex.2	Explaining scientific ideas regarding the scientific concept in discussion
2. NI/A, Les.3, Ex.1	Suggesting/Explaining a scientific idea regarding the scientific problem in discussion
3. NI/A, Les.3, Ex.2	Suggesting/Explaining a scientific idea regarding the scientific problem in discussion
4. NI/A, Les.4, Ex.2	Explaining the scientific idea in discussion
5. NI/A, Les.5, Ex.2: 1	Justifying/concluding the pupils' observations
6. NI/A, Les.5, Ex.2: 2	Explaining/concluding a scientific idea

Table 6.3: Purposes of NI/A excerpts, C1, S1

In one of these examples (Les.1, Ex.2), the teacher not only used her follow-up (turn 21 below) to raise some thoughts regarding the water cycle, dissolving processes and the formation of metals but also to respond herself to these points through a Non-Interactive kind of talk as she dominated it verbally for a long time. While explaining the points she herself raised, she, once again, maintained the control over explanation task.

20.S ₇	The water cycle
21.T	The water cycle in nature, what kind of change? Physical This is of course if there is not any kind of chemicals that dissolve in water when it rains. For example, acid rain happens when we have acidic substances dissolving in rain water, then we will have an acid rain. This is a different case , but the normal water cycle in nature is considered what? Physical change (). Here you said the dissolving of salt. The dissolving of substances. Dissolving of salts in general is considered...The forming of metals...the different kinds of forming that happens in the crust of the Earth are considered physical changes...

She practised this control even in the examples in which the features characterizing Authoritative talk generally seem less persistent. In the following excerpt (Les.5, Ex.2) for example, the teacher was investigating the temperature readings of the groups:

3.T	So, It increased How much was it?	C ₀ E _L
9.T	The group there	I
10.S ₄	It remained the same	R ₄
17.T	...And you, what have you noticed? The group here?	...I
18.S ₆	It decreased ()	R ₆
19.T	It's supposed that the temperature will decrease slightly. You might notice this decrease and you might not and because of this we used the thermometer, why? To get a precise measure. It means that you, whether you were not precise in your measure or maybe the thermometer you used isn't precise enough. So, there is a decrease in temperature.... Any other observation you noticed that indicates the happening of a chemical change? Is there any observation...?	E _v I

When the groups expressed two observations that are not compatible with the scientific view, the teacher commented on the first one without evaluating it (turn3) and did not provide any follow-up for the second one (turn 10). However, after getting the observation she had in her mind (turn 18), she approved it instantly and controlled the talk verbally through the Non-Interactive part in turn 19. Throughout this turn, she assigned to herself the task over assuming the errors that might justify the failure of the groups in getting the desired result.

The four characteristics featuring the Authoritative type in the analysed examples of talk have been explained thus far. Now, I will try to examine the different levels of this type and also locate what has influenced the talk to take these levels.

6.3.2 What has influenced the level of the Authoritative talk?

While introducing this section of the synoptic analysis (6.3), I referred to the idea of different levels within which the analysed Authoritative examples seem to be grouped. This

section explores this idea in detail; firstly, by explaining about these levels and, secondly, by highlighting the factors that specified and influenced these levels.

6.3.2.1 Levels of Authoritative talk

The differences between the Authoritative examples of this stage appear to arise from the persistence of the features of Authoritative talk described in detail in the previous section. In some examples, all of these features seem to characterise the talk while in others, some of these features disappear completely or look less evident. This main attribute of difference is what has resulted into labelling the Authoritative talk into three levels of high, mid and low:

Level 1: High-Authoritative talk

This is the most evident level of Authoritative talk in the analysed examples. In this first level, all features of the Authoritative talk emerge to give it the highest level. The evaluative voice of the teacher persists strongly and, therefore, the evaluative move dominates the follow-ups. With the absence of the neutral and challenging voice of the teacher, the comments and elaborative follow-ups disappear. This imposes the sequence of the (I-R-E_v) through the whole pattern of the talk and results in more pupils participating in the exchange but with very short contributions. The high authority of the teacher in this level appears evidently through her control over the explanation task which refers, in turn, to a continuous movement of the talk towards highly-defined scientific views. Here is an example of this level:

- Excerpt 1 (Les.1, Ex.1): I-R₁-E_v-R₂-E_v-R₃-E_v-I-R_{4,1}-E_v-I-R_{4,2}-E_v-R₅-E_v-I-R₆-E_v-...

1.T What are the physical properties? S ₁	I
2.S ₁	The colour	R ₁
3.T	The colour, good. But we need to pay attention to something here. Right, colour is a physical property but also can be? Chemical property. So I wouldn't take it now as a distinctive one, Ok? S ₂	E _v
4.S ₂	We can say melting	R ₂
5.T	Instead of saying melting, I say melting point. It's a physical property, why?... I mean girls if the substance was melting and then went through a freezing phase. Can't be returned back to its first state? Yeah it's possible, you get it? S ₃	E _v I, R _g F

Level 2: Mid-Authoritative talk

This is less evident among the analysed examples. It is mid-level in the sense that although it can be easily recognised as Authoritative type of talk yet it reflects less control on the part of teacher. This is largely because of a bigger and effective contribution from the pupils as the teacher opens the talk to their personal views. Hence, the movement of the talk towards the scientific view cannot be noticed in the pupils' participation but is manifested, very strongly, in the teacher's. Although the pupils play a 'small' role in controlling the talk when presenting their views, yet they seem to have more control over the talk than in the first level. Nevertheless, most of the control is still in the teacher's hand with the persistence of her evaluative voice and the absence of neutral and challenging voices. The following

excerpt is an example of this level:

- Excerpt 1 (Les.3, Ex.2): I-R₁-E_v-R₂-E_v-R₃-E_v

1.T	... What's the reason or what are the errors?	I
2. S ₁	Maybe the way we put the filter paper is wrong	R ₁
3.T	Good, maybe you didn't put the filter paper in the right way, S ₂	E _v
4. S ₂	The filter paper hasn't been folded in a right way	R ₂
5.T	Yeaah, folding the filter paper in the wrong way, what else? S ₃	E _v , I
6. S ₃	Maybe the shaking of the solution?	R ₃
7.T	It has nothing to do with the shaking. Even after the shaking, the solution separates, ha? During the pouring of the solution, I mean when you poured it, maybe you did it quickly and some leaked out at the back of the filter paper and I said pour it slowly. So what do you do in this case? I will repeat the step of the filtration again...	E _v

Level 3: Low-Authoritative talk

This is the least evident of all levels here. The Authoritative talk of this level is distinctive from the first two because the judgment over its authoritative class cannot be confirmed until the very end of the excerpt. The fundamental criteria in making this judgment is the evaluative move through which the teacher offers the scientific view at the end, and, thus, provides indirect evaluation of pupils' views presented throughout the exchanged talk. This means that although the teacher's evaluative voice is there to present the scientific account but it does not dominate. Therefore, the movement towards the scientific view does not persist. This, in turn, allows the neutral voice of the teacher to emerge and produce a pattern of discourse in which the conventional sequence of the Authoritative talk (I-R-E_v) is rarely noticed. As the talk in this level is open to their views, the pupils' share of control is larger than in the first two levels and their contributions are more effective. Here is an example of this level:

- Excerpt 1 (Les.5, Ex.2, Part.1): I-R_{1.1}- C₀- E_L -R_{2.1}-R_g- E_L -R₃-R_g-I-R_{4.1}-R_{1.2}-C₀-R_{1.3}- E_L... R_g- E_v

1.T	...Give me your observations. Which group recorded a rise in temperature? So, after..., the temperature got higher?	I
2.S ₁	Not that much. Just a little	R _{1.1}
3.T	So, It increased How much was it? ...	C ₀ , E _L
4.S ₂	Was 23 #	R _{2.1}
5.S _g	And then increased	R _g
6.T	How much?	E _L
7.S ₃	24	R ₃
8.S _g	24.5	R _g
9.T	...The group there	I
10.S ₄	It remained the same	R ₄
11.T	...So, why have you written, temperature decreased? ()	I
12.S ₁	We haven't written this	R _{1.2}
13.T	I saw it	C ₀
14.S ₁	Before. Cos we didn't shake it well, the reaction didn't happen	R _{1.3}
15.T	You didn't shake it well?! You mean you measured it again after a period of time since the reaction...	E _L
18.S _g	...It decreased ()	R _g
19.T	It's supposed that the temperature will decrease slightly...	E _v

Figure 6.2 summarises the similarities and differences between the three authoritative levels in relation to different points that characterise the talk. It is worth mentioning, however, that the description of Authoritative talk of mid- and low-levels in this figure has been refined in the light of characterised examples from the second case as its teaching showed more of these levels than this case (see Chapter 8). This does not mean that the examples from this case do not reflect the description below. However, the possible precise articulation of this description could not be done without the characterisation from both cases together.

Levels of Authoritative talk	Highest level ----- Lowest level		
	High-Authoritative talk	Mid-Authoritative talk	Low-Authoritative talk
Frequency of follow-ups	Evaluative moves dominate	Evaluative moves persist	Evaluative moves emerge less frequently and comments and/or elaboration appear frequently
Pattern of discourse	The (I-R-E _v) sequence persists	The (I-R-E _v) sequence persists	The (I-R-E _v) sequence emerges less frequently and the (I-R-C ₀ /E _L) sequence appears frequently
Pupils' contribution	Talk is not opened to personal views	Talk is opened to pupils' superficial views	Talk is opened to more in- detail pupils' views
Features of the talk	-Dominance of the evaluative voice through the initiation & follow-up moves	-Dominance of the evaluative voice through the follow-up move	-Absence of the evaluative voice until the very end of the talk
	-Movement of the talk towards highly-defined scientific view	-Movement of the talk towards the scientific view	-Movement towards the scientific view at the very end of the talk or through the pupils' scientific views
	-Absence of the neutral/challenging voice of the teacher	-Absence of the neutral/challenging voice of the teacher	-Emergence of the teacher's neutral and elaborative (not challenging) stance
	-The teacher controls the talk strongly	-Pupils share little control in presenting superficial views	-Pupils share more control by presenting more in-detail views

Figure 6.2: Levels of Authoritative talk

6.3.2.2 What has influenced the authoritative levels?

Classification of talk into Authoritative and Dialogic types is based on the teacher's control of the CT. Therefore, it may be expected to assign the major attribute of driving the talk in an Authoritative way to the teacher. Overall, the characterisation of the Authoritative talk in section 6.3.1 signifies a teacher with an attitude to control the talk and lead it in the direction assumed by her as the right path to the scientific view. However, the teacher cannot have the sole influence over the talk. She exchanges the talk for some reason (the purpose) with someone (the pupils) about something (the content) and through some kind of tool (the language). This means that the authoritative voice of the teacher might be supported by some factors and unsupported by others, and in this way, the influence of other factors may

support or change the type of talk and its level set by the teacher. While following this issue in the analysis chapters, I have examined the influence of the pupils on the one hand, and the influence of some contextual factors on the other. The influence of pupils in specifying or changing the direction of the talk is not anticipated to happen intentionally. In other words, pupils do not plan to exercise such influence. Concerning the contextual factors, I have focussed primarily on the interaction between the purpose and the content of the talk in addition to the teaching intervention. However, both the purpose and the teaching intervention have been inferred in this study from the content of the talk. The influence of the contextual factors is built then around the nature of the content.

1. Pupils' influence

If we perceive the talk as a mutual interchange and construction between the teacher and pupils, then one way to investigate the pupils' influence would be to focus on the pupils' responses and their overall contribution to the talk.

In the light of their perception of the teacher's power and in response to her authoritative practice, the pupils did support the high authority of the teacher in most of the examples of this stage. On the one hand, all the lessons here were devoid of any question by the pupils in contrast to the lessons of the second case, in which the pupils were asking about different issues related directly and indirectly to the taught topics (see Chapter 8). On the other hand, as the pupils' participation was restricted to only responding to the teacher, they were doing this by trying to recite what the teacher wants to hear regardless of their thinking:

11.T	...And which substance formed the precipitate? And which has dissolved?	I
12.S ₁	That a precipitate, It's sodium chloride	R _{1,6}
13.T	Sodium chloride is a precipitate?!	F
14.S ₁	No, the opposite # calcium carbonate	R _{1,7}

In this excerpt (les.4, Ex.2), S₁ offered the answer of sodium chloride as a precipitate. When the teacher repeated her answer with a wonder tone, S₁ immediately changed her answer to the only other possibility. She did not insist on her answer, nor did she ask for a justification or any kind of explanation. In another example, a pupil was talking about certain experimental observations in her attempt to satisfy the teacher although the context has indicated that she did not experience those observations:

7.T	What's your proof that it's a chemical change?	F
8.S ₂	Change in colour?	R _{2,2}
9.T	Change in colour. What's it? I want strong sign	F I
10.S ₂	If we heat it we won't find – we won't notice the same -- it's the same	R _{2,3}
11.T	If we heat it! But as an observation you noticed during the work, during the experiment. You noticed something, obvious as a sign #	F I
12.S ₂	Bubbles	R _{2,4}
13.T	Bubbles?! S ₃	F

In this excerpt (les.4, Ex.1), the teacher asked for evidence regarding a certain chemical

change which was to be concluded from the first experiment in which this change happened. However, her reaction to the indicator of change in colour that S₂ offered in turn 8 shows that she was interested only in hearing a specific indicator already in her mind regardless of whether the pupils noticed it or not. After this, S₂ responded by trying the answer of 'Bubbles' with the hope that it might work as the sign that the teacher is looking for. Again, S₂ did not hold onto her observation nor did she ask for an explanation for why her observation cannot be considered as evidence. Therefore, it can be argued that with such reactions to the teacher's practice, the pupils did contribute to the authoritative influence of the teacher. In fact, I have not come though any example that shows the pupils, in this case, influencing the exchanged talk in a way that led it in a direction different from the one set by the teacher or that could lessen the authoritative level imposed by her practice.

2. Contextual factors' Influence

As far as the contextual factors are concerned, there are indicators of influence over the level of the Authoritative talk in some examples. The way in which this influence is investigated here, is by looking into the examples found different from the standard practice. As the standard practice shows a high-level Authoritative talk- like the one illustrated in this case- and is mainly attributed to the influence of the teacher, then the influence of other factors can only be scrutinised by looking into examples that showed lower levels of Authoritative talk. The following excerpt (Les.5, Ex.2) contains two parts that give examples of how the content, as a contextual factor, can affect the level of Authoritative talk. Although the two parts share the same purpose and the same nature of empirical content, yet the context illustrates how the subject matter of empirical content has lowered the authoritative voice of the teacher in the first part, in contrast to the second one in which the teacher kept her high intellectual control over the talk:

1.T	...Give me your observations. Which group recorded a rise in temperature?() So, after..., the temperature got higher?	I
2.S ₁	Not that much. Just a little	R _{1,1}
3.T	So, It increased How much it was? ...	C ₀ , E _L
4.S ₂	Was 23 #	R _{2,1}
5.S _g	And then increased	R _g
6.T	How much?	E _L
7.S ₃	24	R ₃
8.S _g	24.5	R _g
9.T	... The group there	I
10.S ₄	It remained the same	R ₄
11.T	...So, why have you written, temperature decreased?	I
12.S ₁	We haven't written this	R _{1,2}
13.T	I saw it	C ₀
14.S ₁	Before. Cos we didn't shake it well, the reaction didn't happen	R _{1,3}
15.T	You didn't shake it well?! You mean you measured it again after a period of time since the reaction...	E _L
18.S _g	...It decreased	R _g
19.T	It's supposed that the temperature will decrease slightly...	F

	Another observation you noticed that indicated the happening of a chemical change? Is there any observation...?	I
20.S ₅	The rising of bubbles	R ₅
21.T	Bubbles rose?!	E _v
22.S ₆	The change of colour	R ₆
23.T	The colour changed ^ In how many groups the colour has changed in this step?... So, Is this an evidence of a chemical change or not?	E _v I, R _g I
24.S _g	Evidence	R _g
25.T	Evidence...So, we have here a change in colour and decrease in temperature...	E _v

Through the turns (1-19), the teacher was trying to work on a certain issue, regarding the conducted experiment, by investigating pupils' observations. In turns (19-25), the same purpose and teacher intervention is repeated. The talk in the first part exhibits two evaluative follow-ups within 19 moves, whereas, the second part also shows two evaluative follow-ups but within 7 moves only. In the first part, the teacher waits until the very end of it to give an evaluation, while in the second part, she immediately provides an evaluation in its third turn. This comparison gives birth to a question that why did the teacher's reactions differ between the two parts that were initiated for the same purpose and shared a content of the same type?

In the first part, the teacher was investigating the temperature readings of the groups. She was not sure of the results, so she chose to start asking about one of the alternatives; the rise in temperature. The videotaped group announced this rise but the teacher wanted to know more about it. Then the whole group participated in providing the required information. Accordingly, the pattern of the talk took unusual sequence (e.g. in turns 1-8: I-R_{1.1}-C₀-E_L-R_{2.1}-R_g-E_L-R₃-R_g). It is unusual for Authoritative talk because:

- more than one pupil was offering answers without directly being asked to do so, which means that the control over the talk was not entirely possessed by the teacher;
- the teacher was not evaluating the responses. She was just commenting on some of them and asking for more clarification for others;
- the teacher, in some incidents (e.g. after turns 8 & 10), did not provide any kind of follow-up to the pupils' responses, not even a comment;
- the teacher, in turns (11-17) was seeking clarifications from the videotaped group for something she was confused about. In this situation, the group was, indeed, the source of unknown information to the teacher.

Such characteristics indicate a retreat of the evaluative voice of the teacher and a decline in the authoritative level of the talk. Nevertheless, the teacher was still looking for what she thinks was the correct view. When one of the groups uttered that view, she instantly approved it and assumed certain errors with the groups that did not get that result.

Quite the opposite, in the second part (turns 19-23), the empirical outcome regarding the

change of colour was spotted by all the groups. Therefore, when the teacher asked for a second sign observed in the experiment, the change of colour was the one in her mind already as she was aware that all the groups knew it. What happened, however, was that S₅ offered a sign that the teacher was not aiming for. The teacher reacted with an expected authoritative attitude based on her performance throughout the lessons; disapproving instantly the undesired responses by repeating them with a wonder intonation, and approving the desired ones (offered by S₆) by repeating them with an affirming intonation:

S₅: The rising of bubbles , T: Bubbles rose?!
S₆: The change of colour , T: The colour changed ^

Here, it can be argued that the subject matter of the content has drawn the difference between the two instances of the talk. In the first part, the teacher was aware that with that experiment, it was not very likely to get the actual result of a decrease in temperature. That resulted in her showing more leniencies towards the groups' responses. Hence, it was something about the subject matter in its empirical form that had coloured the talk to be of lower authority.

In another example (Les.3, Ex.2), the nature of the posed question following the purpose of the initiated talk is what seems to contribute to reducing the high authoritative voice of the teacher. The nature of the question and its purpose of investigating a scientific problem (what are the errors that caused the failure of the filtration process?) have resulted in an excerpt with less control from the teacher as some pupils could speak their thoughts out, and their contributions were not directed towards a certain scientific view (refer to p.112-113). This purpose, however, can be seen as an imposition by the empirical content. The failure of the filtration process in some groups, with the fact that other steps were to be performed based on the results of this filtration, had compelled the teacher to open up a discussion about it before repeating it.

These two examples demonstrate that the empirical content could lower the authoritative level of the talk because of its relation to the pupils' own work and observations.

6.3.3 How does the Authoritative talk seem to support/ not support pupils' learning?

This section aims to examine how the analysed CT seems to support/not support pupils' learning in terms of their engagement, understanding and the quality of the exchanged questions and responses. This can be done only when the CT data and its analysis, performed through the framework, provide insights into these indicators. This in itself is a reason of why to follow these three specific issues in addition to their importance as indicators of learning. In other words, pupils' learning can be investigated in terms of other indicators, for example, practical skills but the nature of CT analysis in this study does not provide enough and suitable data for such indicators to be followed. It is even expected that

this kind of analysis would not always be able to provide substantial evidence of the pupils' understanding because its investigation is based primarily on how much the analysed CT is revealing of pupils' views. In this sense, the analysis of the teaching practice dominated by Authoritative talk is less likely to provide the required data. Nevertheless, the pupils' understanding is examined in more detail through the analysis of the focus group discussion. Moreover, the results on this understanding will be linked to the characterised talk, in order to go back to the starting point of investigating how the CT seem to support/not support pupils' learning.

In this case and at this stage, the Authoritative talk dominated, and was mostly of higher levels with very few incidents of lower ones (refer to fig.6.2). The absence of the challenging voice from the talk, the teacher's control over the explanation task in addition to the other described characteristics of Authoritative talk (section 6.3.1), reflect negative indicators of learning. The talk with such characteristics is less likely to support pupils' learning because it is based on diminishing their verbal and intellectual contribution. Because of this particular reason, the available data of CT, here, did not allow the investigation of the pupils' developing understanding. The analysed talk does not reveal the pupils' thoughts of the presented scientific issues, from which their misconceptions, conceptual difficulties or the kind of understanding they have in general can be identified. It is, therefore, the findings only on the pupils' engagement and the quality of the questions and responses that are presented in this section on pupils' learning. More results on pupils' understanding and how the CT in the observed teaching seems to have reinforced those results are presented in the coming section (section 6.4).

6.3.3.1 Pupils' engagement

The examples of talk from this stage show a teacher taking control over the talk, and pupils deprived of any effective contribution or real participation. The authoritative features, themselves, demonstrate this poor engagement as the chances for the pupils to speak out their ideas, to think about what has been presented and to exercise more control over the talk and their learning, were limited. It was limited because of the strong instant evaluation from the teacher, the absence of a neutral voice throughout the talk and the limitation in the elaborative questions for the pupils to explain their views. It happened largely because the teacher assigned the role of explanation and giving judgments to her and restricted the role of pupils in this regard. The different extracts of talk used throughout this chapter illustrate this poor engagement of pupils. In addition, I refer here to some more indicators that point directly to their limited verbal and intellectual participation in guiding the ongoing talk:

1. In most of the examples, the pupils' contributions in the response move were short as compared to the long contributions of the teacher in the initiation and follow-up moves.

Look, for example, at this excerpt (Les.4, Ex.1):

3.T	Dissolving?! How dissolving carbonate #	F
4.S ₁	Mixing	R _{1,2}
5.T	Yeaah, adding the two solutions together, and when I have solutions, I don't say adding. I say mixing. So, the next step is mixing or adding the two solutions together, ok? (B) the kind of change? S ₂	F I
6.S ₂	Chemical change	R _{2,1}
7.T	What's your proof that it's a chemical change?...	F
14.S ₃	... The formation of a precipitate during the work	R ₃
15.T	Yeah, that's good. The formation of a precipitate or a white substance, was before, at the beginning, then what? what happens to it?	F I
16.S ₄	It goes down	R ₄
17.T	It goes down bit by bit. If you have left it for a period of what? Of time then a white precipitate formed (B). Four, the next step What's the procedure we've followed after that? S ₅	F I
18.S ₅	We've done a filtration for the solution	R ₅
19.T	Filtering the solution. Very good. A filtration process. What's the kind of change in this case? S ₆	F I
20.S ₆	Physical	R _{6,1}

2. In some examples, the Authoritative talk, because of very close-ended questions, has called for group answers in a manner that disallowed individual participation. The whole following excerpt (Les.3, Ex.3) illustrates this point as all the responses were uttered by groups of pupils (S_g). It demonstrates the short contributions of the pupils as well:

1.T	Did the substance in the filter paper dissolve in water?	I
2.S _g	No	R _{g,1}
3.T	Look girls, when any substance dissolves, notice that the resulted colour is transparent like the colour of the salt when you dissolve it in water. Have you noticed that there is a white colour?	I
4.S _g	No	R _{g,2}
5.T	So, this substance didn't dissolve in water whereas the substance in the glass2, was how before?	F I
6.S _g	Dissolved	R _{g,3}
7.T	Dissolved in water^. Was how before?	F, I
8.S _g	Dissolved ()	R _{g,4} , F
9.T	See how it feels, rough or soft?	I
10.S _g	Rough	R _{g,5}
11.T	It feels what? Rough....	F

3. The authoritative practice of the teacher appears, in many examples, to result in an obvious neglect of the pupils' thoughts and ideas. Highly demonstrative examples for this come from lesson three, in which the teacher showed a less authoritative orientation when asking for the pupils' expectations in two incidents. I have already gone through the first incident when the teacher asked for the pupils' expectations of the possible errors that might have caused the failure of the filtration process (p.112-113). In the second incident, through Interactive Dialogic talk, the teacher, again, asked for the pupils' expectations; this time about the criteria to differentiate between the chemical substances resulting from the first

experiment. The Interactive parts in both incidents were followed by Non-Interactive Authoritative talk, which revealed the teacher's neglect of the pupils' proposed ideas on the discussed issues.

In the first example, although she approved two sources of errors suggested by pupils, yet she did not consider them when asking the pupils to repeat the filtration process. She had one error in her mind and acted authoritatively when attributing the failure of the filtration to that error, bearing in mind that the process had been done by the pupils themselves.

7.T	...During the pouring of the solution, I mean when you poured it, maybe you did it quickly and some leaked out at the back of the filter paper and I said pour it slowly. So what do you do in this case? I will repeat the step of the filtration again...
-----	---

In the second example, the teacher was directing the pupils towards the idea of the solubility as to be the criterion for differentiating the two substances. She had not recited the idea directly but asked the pupils to conduct a practical activity to examine this property. Through such talk, she was not only imposing the scientific idea authoritatively but also neglecting the views that the pupils had offered during the preceding Interactive talk.

15.T	...Another thing? Now, if I take some of this substance1 and try to dissolve it in water, dissolve it in water. Just a little - a small amount, dissolve it in water, see what will happen to it?...
------	--

The teacher's neglect of the pupils' contributions also emerged in some examples by disregarding the pupils' own empirical observations. While discussing the influence of the pupils and contextual factors on specifying the authoritative level of talk (section 6.3.2.2), I went through two excerpts (Les.4, Ex.1 & Les.5, Ex.2) in which the teacher asked for the signs of chemical change, and the pupils offered those signs based on their observations of the conducted experiments. The following extracts from these examples demonstrate it:

7.T	What's your proof that it's a chemical change?	F
8.S ₂	Change in colour?	R _{2,2}
9.T	Change in colour. What's it? ...	F
12.S ₂	...Bubbles	R _{2,4}
13.T	Bubbles?! S3	F

20.S ₅	The rising of bubbles	R ₅
21.T	Bubbles rose?!	F
22.S ₆	The change of colour	R ₆
23.T	The colour changed.	F

With such a reaction, the teacher was evaluating the 'correctness' of the change in colour or rise of bubbles as signs instead of checking the occurrence of those changes. By confining herself to a certain sign as evidence, she had not only ignored the pupils' thoughts but also their existing observations from an experiment they had done. That had driven those pupils eventually to offer other alternatives they had memorised as signs of chemical change, regardless of their occurrence in the experiment.

Overall, the findings on the pupil's limited verbal participation and the discounting of their

thoughts, suggest that the Authoritative talk, especially, from higher levels does not seem to support pupils' learning in relation to their engagement.

6.3.3.2 Quality of questions and responses

The teacher's control over the explanation task and the absence of her challenging voice resulted in a talk dominated by questions of low quality level as the quantitative representation of the quality of questions illustrates:

Examples of Authoritative talk	Quality of questions		Examples of Authoritative talk	Quality of questions	
	Low	High		Low	High
Les.1, Auth.1	7		Les.4, Auth.2	7	
Les.1, Auth.2	4		Les.4, Auth.3	4	2
Les.3, Auth.1		2	Les.5, Auth.1	1	
Les.3, Auth.2	5		Les.5, Auth.2	7	
Les.4, Auth.1	11	2	Les.5, Auth.3	3	

Table 6.4: Quality of Questions in I/A excerpts, C1, S1

Table 6.4 indicates that out of 55 questions that have been characterised through the analysis of the selected examples by using the framework, only 6 were of high cognitive level. Similarly, most of the pupils' responses have been characterised as of low quality. The quantitative results demonstrate that out of 76 responses, only 6 were of high quality as table 6.5 illustrates:

Examples of Authoritative talk	Quality of Responses		Examples of Authoritative talk	Quality of Responses	
	Low	High		Low	High
Les.1, Auth.1	7	2	Les.4, Auth.2	9	
Les.1, Auth.2	10		Les.4, Auth.3	10	1
Les.3, Auth.1	1	2	Les.5, Auth.1	3	
Les.3, Auth.2	5		Les.5, Auth.2	10	
Les.4, Auth.1	12	1	Les.5, Auth.3	3	

Table 6.5: Quality of Responses in I/A excerpts, C1, S1

The image of the questions and responses that have been characterised as of high level looks even less promising when checking these moves in their contexts. Table 6.6 offers the six questions and their characterisation of the inferred cognitive processes:

1)...what are the errors? (Les.3, Ex.1)	I	* H: CP of 'Create, hypothesise', open Q
2)...what else? (errors)	I	* H: CP of 'Create, hypothesise', open Q
3) Physical, why? (Les.4, Ex.1)	F	* H: CP of 'Understand, explain'
4)...but still you've not proved why it's physical change?	I	* H: CP of 'Understand, explain'
5)...In the rocky area surrounding the cave, there are salts of what? (Les.4, Ex.3)	I	* H: CP of 'Apply, implement'
6) Anyone knows the name of this substance? The substance forming...as a result of the reaction of the calcium carbonate with the acid	I	* H: CP of 'Apply, implement'

Table 6.6: Categorisation of high quality Questions in I/A excerpts, C1, S1

As noticed above, the six questions can be gathered further into four high initiations only, as the questions about the errors (1 & 2) and justification of physical changes (3 & 4) repeat.

Even more interesting is that the high quality of the last two questions (Les.4, Ex.3) had been diminished to a lower level. To make this point clear, there is a need to see these two questions in their context:

1.T	...In the rocky area surrounding the cave, there are salts of what? Anyone knows? Based on all what we've said, salts of what? S ₁	I	H
2. S ₁	Calcium chloride...	R ₁	
4. S ₂	...Sodium chloride	R ₂	
5.T	Let me ask you if the salts of calcium chloride and sodium chloride, the continuous fall of rain upon these salts, will they remain in this area?	F I	L
7.T	What happen to them? They dissolve and go down and the water will evaporate and they will remain as a precipitate below. Right or not? Salts of what? S ₃	F I	L
8. S ₃	Calcium carbonate...	R ₃	
13.T	...Anyone knows the name of this substance? ...as a result of the reaction of the calcium carbonate with the acid	I	H
14. S ₅	Potassium chloride...	R ₅	
16. S ₆	...Calcium chloride...	R ₆	
18. S ₇	...Sodium chloride...	R ₇	
21. S ₈	...Calcium nitrates ()	R ₈ , F	
22. S ₉	Calcium carbonate	R ₉	
23.T	Calcium bicarbonate. Excellent...The substance forming here is CaCO ₃ ...	F	

After two incorrect 'guesses' by the pupils, the teacher posed the same question in turn 1, again in turn 7. This time, however, she gave a very obvious clue of the desired answer, which had been immediately offered in turn 8. This means that the high-quality question was reduced to a low-quality one, which evoked the correct answer but one to be characterised as of a low cognitive level. Similarly, through the talk exchanged between turns (13-23), the teacher asked a question of a high cognitive level in turn 13, and had to disapprove many responses before getting the correct one. When S₉ offered the desired answer in turn 22, the teacher did not ask her for any kind of explanation that might reveal her thoughts. Instead, the teacher herself offered a detailed justification for that scientific view in turn 23; the thing that deprived the original question in turn 13 of the effect of its high quality. A major and sensible conclusion that can be drawn from this example is that the teacher was aiming to extract the desired correct answers and paying no attention to what the pupils think about those answers: whether they understood them or not in the first place. This moves us, in turn, to discuss the quality of the 6 responses judged as of high quality and displayed in table 6.7:

Geometry of the substance	* H: unusual articulation of grouping together different physical properties
Density	* H: unusual answer in terms of going to more abstract level
Maybe the way we put the filter paper is wrong	* H: CP of 'Create, hypothesise'
The filter paper hasn't been folded in a right way	* H: CP of 'Create, hypothesise'
Cos the precipitate in the filter paper can be returned back to the glass #	* H: CP of 'Understand, explain'
Calcium bicarbonate	* H: Unusual in its context

Table 6.7: Categorisation of high quality Responses in I/A excerpts, C1, S1

I explained earlier that the characterisation of S₉'s response in the previous excerpt as of high level was based on its originality due to the absence of a clarification from the pupil (refer to section 6.3.1.3). In fact, 3 of the 6 responses judged as of high quality have been classified so because of their uniqueness in their contexts. Such judgments then are open to debate as the pupils' thinking was not revealed. This means that there are only 3 responses out of 77 that more definitely reflect high cognitive processes in thinking about the discussed issues.

Overall then, the finding of the overwhelming low quality of the questions and responses, suggests that the Authoritative talk of higher levels, especially, does not seem to support pupils' learning in relation to the cognitive processes employed throughout the exchanged talk. A summary of all the issues discussed in this section (6.3) is offered in the concluding chapter (sections 10.1.1 & 10.1.2). In what follows, I explore the pupils' conceptual understanding based on the analysis of the focus group discussion, and trace the results back to the teaching.

6.4 Commenting on the pupils' conceptual understanding using data from the teaching and focus group's setting

This section addresses the following RQ (section 5.1), prior to the TI (a):

2.2a What evidence is there of pupils' conceptual understanding, following the observed teaching?

Subsequent to the five videotaped lessons on the topic of 'substance changes', the selected group of pupils from this class was given the bubble dialogue sheets to fill in (see appendix 3). The opinions expressed in these sheets were used then to initiate the discussion in the focus group setting. In this section, I present the findings on the pupils' conceptual understanding²⁰ from the analysis of the focus group discussion and following its results back to the teacher-pupil talk and the group discussions through teaching. I have also used, sometimes, the pupils' written responses in the bubble sheets when useful in providing more insights into the discussed issues. A few points, however, need to be highlighted first in relation to the context of such analysis:

1. The aim of the focus group discussion was not to investigate the pupils' pre/mis/alternative conceptions about the physical and chemical changes in general. It was designed and guided to explore the pupils' understanding in relation to the main pieces of information presented in the five videotaped lessons. In overview, the teaching of this topic in grade nine in the Omani curriculum comes within the macroscopic domain only. It deals with the substances' physical and chemical

²⁰ Understanding and conceptual understanding are used interchangeably in this study

properties, the main characteristics of physical and chemical changes, and the observable signs of chemical change in chemical reactions. It does not go to the microscopic details of explaining what happens at the level of molecules and atoms in relation to the re-arrangement of bonds and re-grouping of atoms. It also does not pay attention, at this stage, to the symbolic representation of chemical changes²¹. Therefore, no details relating to the microscopic level and symbolic representation in approaching chemical change were included in the discussion arranged for probing the pupils' conceptual understanding. It is worth mentioning that conceptual difficulties on this topic might arise because of the planning of the curriculum itself, which separates the macroscopic explanation of the substance changes from the microscopic and symbolic ones. However, within the examples and the questions presented through the teaching and the focus group discussion, explanations at the macroscopic level are believed to be sufficient enough to enable the pupils to give the correct judgment on given changes.

2. Here, there is the debatable attempt to investigate the pupils' understanding as influenced by CT. Through the focus group, I followed the strategy of challenging the pupils' presented views and using their contradictory opinions to stimulate more talk on the discussed points, in addition to the interaction driven by the pupils themselves. Such a discussion could reveal more of the pupils' thoughts. Yet, there is the unavoidable effect of the pupils refining and developing their views because of 'thinking aloud'. This is in addition to other predictable and unpredictable factors that might have influenced the pupils' views apart from the CT itself. Accordingly, I reflect on the pupils' conceptual understanding and difficulties in relation to what had been said in the classroom; whether through the teacher-pupil talk or the group discussions that took place in the teaching.
3. This analysis in investigating the pupils' understanding is built over the exchanged talk; whether the pupil-pupil talk in the focus group setting and the group discussions through the teaching or teacher-pupil talk. Because of this kind of analysis, the pupils' conceptual understanding has been investigated as a whole for the five pupils in the participating group (with focus on certain pupils when needed). This means that the unit of analysis here is the scientific piece of information within the specified categories, and not the pupil. The analysis also includes an attempt to report on whether there are conceptual difficulties in understanding this information or not, and if yes, what are they? and Can they be traced back to the teaching? This meets,

²¹ This is so, aside from the main chemical equation on the experiment of 'the changes leading to the formation of rocks' that was presented to summarize the main process of the experiment.

actually, with the purpose of investigating pupils' learning in this study in its relation to the recorded CT.

In what follows, I trace the pupils' understanding of the main conceptual issues that were raised through the teaching, with reference to the following scientific views:

- Change of external/internal features of matter: Matter has external features related to its outward shape, and internal features related to its interior structure; in physical change, only the outward features change; in chemical change, both outward shape and interior structure change.
- Formation/non-formation of new substance: in physical change, no new substance is produced; in chemical change, a new substance is produced.
- Reversibility/Irreversibility: Substances that go through physical change can be returned back, in most of the cases, to their initial state; substances that go through a chemical change cannot be returned back, in most of the cases, to its initial state.
- Possible evidence for chemical change: These are the signs that are considered as possible evidence of chemical change: Change of colour, change in temperature, rise of bubbles (gas), and formation of precipitate. They are taken as evidence only if they indicate the formation of a new substance because of a chemical reaction.

These ideas are followed in this analysis through two main categories of 'characteristics of physical and chemical changes', and 'evidence (signs) of chemical change'.

6.4.1 Characteristics of physical and chemical changes

Within this category, there are three subcategories of the characteristics: change in substance features, reversibility and formation of new substance. Although separated for the purpose of analysis, the three are interdependent and are expected to work together to give a judgment about the kind of change. From the scientific point of view, in fact, the two characteristics of change of features and reversibility can be both approached in relation to the characteristic of the formation of a new substance. If the whole picture of the characteristics, together, is not obvious in the pupils' minds, then they are expected to rely on a certain characteristic to give a judgment. This judgment can be correct or incorrect depending on how the pupils are approaching the implemented characteristic(s).

6.4.1.1 Change of external/internal features

With the progression of the discussion in the focus group, it became obvious that the pupils were not using this criterion to judge the kind of change whether physical or chemical. In arguing about a certain change, they had, sometimes, talked about the change in external or internal features, but relied heavily on the characteristic of reversibility in supporting and defending their judgment:

S₅: ... (Chemical because) It freezes and can't get back to its liquid state (the egg)

R: When I freeze water, doesn't it transform from liquid to solid?

S₁: Yeah it can be got back, but the egg, no, it can't be, no way

In fact, there are two sources of confusion that seem to affect the pupils' thinking about substance changes in terms of the external and internal features, and which can be followed back to the teaching itself. Firstly, there seems a mix up between the physical and chemical features on one hand, and the characteristics of the two kinds of change on the other hand. For example, when the teacher asked the class in the first lesson to discuss in groups the physical and chemical features of a piece of iron, the mix up can be heard in many utterances. It is evident in the two incidents of group discussions below:

S₄: the chemical features are the ones that change the shape, colour, taste, texture and the temperature (reading from the paper sheet in which they are recording their answers)

S₃: ...girls, how comes the shape is a chemical feature?

S₁: the shape? Umm, I think it is physical, cos if it changes, we can get it back (S₃: yeah)

S₂: No, like the paper if it burned. Can you get it back? We can't

S₄: ...This can be physical or chemical (referring to the change in the melting of iron)

S₂: yeah (silence)

S₄: it can be both, a physical or chemical feature (referring to the melting of iron)

This mix up can also be spotted out in the teacher's utterances in some incidents, which might be expected to have affected the pupils in their thinking and talking about substance changes. Her imprecise articulation of the relation between the physical or chemical features and the characteristics of each change can be heard in the following utterances, for example:

T: what's the physical feature that if a change happened to it, the substance can be got back to the features that it was in previously?...

T: ...so this feature can be got back to it?...

Another source of confusion is the attempt to draw a distinctive line between physical and chemical features, as the following utterance from the focus group illustrates:

S₃: Physical change is an external change, changes the outward shape of the substance. It doesn't change its internal features... Chemical change is the changing of the internal features of the substance...

The simple fact that the chemical change does change both the external and the internal features was not evident. I anticipate that if a discussion were opened on this point directly, the pupils would have agreed on it and would have not found it difficult to absorb. However, they did not seem to have thought about it. In the bubble sheets, S₅ expressed the view that the change happening to the egg is a chemical one because:

"what is happening to the egg is that it starts condensing and gathering its particles to be a fried egg inside the shell"

When she expressed her view again in the focus group discussion and I tried to compare it to what happens when water freezes, none of the group argued about the change of state as can possibly accompany any chemical change or simply that chemical change entails the change of both internal and external features. Instead S₁ was heard defending that:

R: When I freeze the water, doesn't it transform from liquid to solid?

S₁: Yeah it can be got back, but the egg, no. it can't be, no way

This can be followed back to the teaching itself as the transcription does not show an explicit discussion on this point. Quite the opposite, S_b, in the extract below, seems to identify the point of the chemical change affecting both the external and the internal features, but the uptake of the teacher was not helpful to bring it to the awareness of the class:

T: ...What proves that a chemical change happened to this paper?...

S_a: that it cannot be returned back after it burned

T: yeah. It cannot...another thing

S_b: the features of the paper changed

T: the features changed. External or internal features?

S_b: external and internal.

T: external and internal. Maybe. Good²²

In another incident, the teacher even denied the change of external features in chemical change; maybe without being aware of:

S_a: it's a change in the features of the substance in the way that you can get it back to...

T: excellent. It's a change in the internal features and not the external features, so what?....

It might be expected, therefore, that the pupils' view of this characteristic was not clear enough to be used confidently in making a judgment on the kind of change due to the sources of confusion discussed above.

6.4.1.2 Formation/non-formation of new substance

When the pupils were asked to define their views on both types of changes during the focus group setting, the characteristic regarding new substance was heard in their articulations:

S₃: Chemical change... produces a new substance out of the reaction.

S₄: Chemical change, a reaction happens. There is always a reaction...so it produces a new substance. Physical change, there is no reaction and doesn't ummm, produce a new substance. The substance remains the same.

This characteristic was used in few incidents to justify the judgment on the type of change:

S₅: cos the egg becomes a new substance

S₄: the egg is a Protein substance. When it's been fried, a new substance that I don't know is produced

S₄: physical, cos its features didn't change. Cos it's a shell a shell (egg shell being broken). Its ingredients the same ingredients. Basically it hasn't reacted with anything. With what it reacted so it produces a new substance? (arguing others who say it is chemical)

In fact, aside from this last extract, the criterion of the formation/non-formation of a new substance was absent in the making of a final judgment by the pupils when they were differing or getting confused in deciding about the kind of change. Overall, it can be said that this criterion was not evident as compared to the reversibility criterion and the signs, although all characteristics and signs of chemical change lead, eventually, to it. Irreversibility means that the old substance is not there anymore, and all the signs indicate

²² Extracts with T (Teacher) are from the teacher-pupil talk during the lessons, and letters a, b, c...are used to label students for not to mix them with the group pupils for whom I use the 1,2,3... digit labels.

the formation of a new substance. Back to the teaching, there were incidents in which the talk seems to relate some features of matter or the ir/reversibility characteristic to the characteristic of the formation of a new substance. However, this relation was discussed neither explicitly nor in a detailed manner:

T: iron, if it happened that this substance reacted with another substance...then, what will you have?

S_a: a new substance

T: what? A new... Does the internal structure of the substance is also an iron?..

T: Oxidisation. The capability of the substance to be oxidised is considered a chemical feature, cos if the substance oxidised, can you get it back to its original state?

S_a: No

T: cos it produces a new substance...

S₁: the fourth step...Chemical

S₄: yeah chemical, cos there is a reaction. Its features change, the substance change, and it produces a new substance

In other incidents, there was no mention of this criterion at all, although the context was necessitating the implementation of this criterion in justifying the kind of the change. The discussed change in the extract below, for example, could be explained better in its relation to the formation of a new substance by referring at least to the rising gas as a new substance:

T: ...adding the acid to the precipitate, the kind of change?

S_a: chemical

T: how do you prove it?...

S_b...the rise of gases (at this stage, the changes were discussed in terms of the characteristics and not yet in terms of the signs)

T: the rise of gases is a sign of the change, and also the precipitate, what happened to it? Did it remain as a precipitate with a white colour?

S_c: it melted

T: melted. Good. The precipitate melted and the rise of gas

Therefore, it seems that the less evident presence of this criterion in judging the kind of change through the teaching has contributed to its less evident presence in the pupils' justifications through the focus group discussion.

6.4.1.3 Reversibility/irreversibility

This is the criterion mostly used by the pupils to judge the kind of change, especially the physical one, as the signs play the biggest role in indicating the chemical change. In defining both kinds of change through the focus group discussion, the following conventional description was frequently heard:

S₃: physical change is...and we can get it back...chemical change is...and it can't be got back

Also this characterisation has been advocated through the teaching as some of the previously exemplified extracts demonstrate. Surprisingly, though, the ir/reversibility is a mistaken conception in describing the substance changes. From a scientific point of view, if we talk about the ir/reversibility in terms of the process of the change itself, then most of the chemical changes can be reversed. If we talk about the re/irreversibility in terms of the substance, then again the old substance that is transformed to a new one through a chemical

reaction can be got back, sometimes, through another chemical reaction. For the physical change, the substance is there, and there is no new substance that needs to be reversed to an old one.

Nevertheless, the term of ir/reversibility was not used during the teaching of substance changes. Instead, the articulations of ‘can/cannot be got back/ returned to its initial state’ were used to indicate this characteristic. In such articulations, however, it was not obvious whether the talk is about the process of the change or the substance that can or cannot be returned. English is gender neutral, whereas, Arabic is not. In Arabic, change is a masculine and substance is a feminine noun. In the context of talking about ir/reversibility throughout the lessons, there was an alternating use of both the masculine and the feminine pronouns; the thing that means that ir/reversibility has been related, probably without awareness, to both concepts of the substance and the process of the change itself:

S_a: ...a physical change happened (forming a paper in the shape of plane) cos...and can be returned back to how it was before

T: ...we can get it back to its initial state (it refers to the substance, feminine pronoun)

T:why physical?

S_a: ...cos it can got back (it refers to the process of change, masculine pronoun)

T: get back alone?

S_c: no, we get it back

T: yeah, good. Cos it can be got back to its initial state

In the textbook, though, there was a far more precise articulation, as follows:

‘the substances that go through physical change are distinguished that they can be returned back in most of the cases to their initial state...the substances that go through a chemical change cannot be returned back in most of the cases to its initial state. When burning wood for example, the produced ashes, carbon dioxide and water vapour, cannot be returned back to wood or a tree again” (MOE, 2007, p.82).

Evidence from the teaching and the focus group discussion illustrate quite strongly how the haziness in specifying the meaning of the ir/reversibility through the teaching has influenced the conceptual understanding of the pupils. In presenting the conceptual confusion between correct and mistaken conceptions in approaching the substance changes in terms of this characteristic, I chose to focus on two pupils (S₁ & S₄); the ones most persistent in defending their extreme opposite opinions. The other three girls in the group were hanging between the two’s expressed views, supporting one or another, and their contributions will be presented when useful in the context.

One of the conceptual difficulties in dealing with ir/reversibility criterion was the pupils’ understanding of the reversibility in physical change as the necessity to get the substance back to its initial external shape; i.e. if we get the substance back, exactly to how (and not what) it was, then this is a physical change, and it is not if we failed to do so. The other difficulty that was interdependent with this one was that the pupils did not perceive the ir/reversibility characteristic as a possibility in the first place. In other words, although they

used the word might/might not or can/cannot while talking about getting back the substance/change (as can be seen in the examples below), yet their argument showed that they were not taking the possibility into their consideration. Therefore, they could not accept that some changes can be physical, but the substance cannot be returned to its initial state, and the opposite for chemical change. What happened, rather, that when they were failing to see how the substance can be returned back to what and how it was, they were getting confused or, more radically, changing their judgment about substance as not to be physical. The following extracts reflect both of the two interdependent difficulties:

S₁: chemical (the shell of egg being broken), cos we can't get it back...

S₄: physical, cos its features didn't change. Cos it's a shell, a shell. Its ingredients are the same ingredients. Basically it hasn't reacted with anything. With what it reacted so it produces a new substance?

S₁: but we can't get it back...

S₂: Frankly, I'm confused, physical or chemical. In physical change we might get the substance back, but if we broke the shell we can't get it back. No way, but it's not chemical cos its features have not changed at all

S₁: physical (tearing a paper). But might be chemical cos we can't get it back, cos if you glue it, it will mix with new substances

S₃: it can be. We might add water with starch...

S₁: but this will change its features

S₃: we might put it in some kind of machine...

S₁: but for now, we don't have this machine

S₅: chemical in this situation (the evaporation of water when an egg being fried in) cos we didn't put a cover for the water to condense

R: So, you consider it chemical cos you can't get it back?

S₃: Yeah

S₄: I think it is. No, I don't think. Surely it is physical, cos basically that water flew into the air. It can be substituted with another water, I mean. Even if it's not put there (she means the cover) If they can't make use of the water that evaporated. But it's physical, how? Cos the water can be got back, not this, to its natural state

S₂: I agree with S₄ that it's physical change, cos if we noticed the sea...

S₁: Ok, but it didn't happen that it condensed here...

The problem for S₁ and her supporters in these extracts is that they could not imagine how the discussed substances in those particular situations can be reversed to how they were before; how to do it practically. S₄ and the others could not explain simply that 'we' might not be able to get the substances back, but this does not mean that it is not possible. Most importantly, apart from S₄'s defence regarding the eggshell, there is no mention of the main characteristic of physical change of the non-formation of a new substance. Simply, if the understanding of substance changes in terms of this criterion was evident enough in the pupils' minds, such argument on the aforementioned extracts would be expected not to go on, in the first place.

Going back to the group discussions that took place through the teaching, especially in lesson three, the same confusion could be heard, where S₁ and S₄ appeared to take an opposite position to what appeared later on in the focus group discussion:

S₄: now the heating (heating the solution of salt), physical or chemical?...if evaporates, we can't get it back
 S₅: if you condense it
 S₄: but wait a sec. we have to do something for the water to condense. water flied into the air
 S₁: Umm, I know. You know what we do-we put a glass sheet above it, or umm
 S₄: it doesn't need that. It is saying, now what's happening, a physical or chemical change?
 S₂: physical
 S₅: chemical...
 S₄: ...water evaporates and goes away, where can we get this water from?
 S₁: we get some water-normal
 S₄: is it ok to bring another water?
 S₅: it can't be, it has to be the same water (girls seem not to hear her)
 S₁: yeah cos the same salt
 S₂: ...and the salt remains, we do the experiment again..
 S₁: yeah, we can bring another water
 S₄: so it's physical?
 S₁,S₂: yeah physical

This can be perceived in the following scenario; S₄'s understanding has developed towards a more scientific account while S₁'s conceptual understanding seems to have developed in the opposite direction. However, there is a need to pay attention to an important point. It relates to the details of this example of heating the salt solution compared to the evaporation of water that the aforementioned extract from the focus group has shown. As far as the evaporation of water is concerned, S₁ and her supporters refused to consider it a physical change because they think that they cannot get back the substance (water) that went through this change. Contrarily, in the case of the heating of the salt solution, they simply thought that they could get back what they consider the main 'thing' they started with. That is the solution together, and not the separated substances of the water and salt. They can simply add any water to the salt after the evaporation of the 'old' water because of the heating. Therefore, they can get the solution back; the thing that makes the change physical according to their thinking. In short, the conceptual difficulties that appeared during the group discussions through the teaching persisted during the focus group discussion. However, S₄ seemed to have improved in taking up the whole issue between the two events.

It is worth mentioning, moreover, that none of such arguments appeared during the CT, that I can go through to provide more insights into pupils' conceptual difficulties in this regard. Through the teaching, general views about the kind of the change and the justification in relation to one of the characteristics were presented by the pupils and evaluated by the teacher without the teacher opening a detailed discussion, and without the pupils arguing about the teacher's judgment. However, it is interesting, while going through the transcription of the recorded CT, to find exchanges of teacher-pupil talk that seem to support the analysis concerning the pupils' responses to the changes of water evaporation and the heating of the salt solution. In one incident in lesson 4, the teacher was discussing the kind of change in the second step of the first experiment of dissolving sodium carbonate in water, and at the end of this discussion, the following exchange took place:

T: ...also to prove that it's really physical, you can through the process of what?

S_a: evaporation

S_c: heating, good. by heating it. If the same salt that you've dissolved remained at the bottom of the tube, then this is evidence of what kind of change?..(physical)

Here, the teacher focused only on the salt which has been taken, added to water, dissolved in water and then got back (in the focus group, all the girls agreed that the dissolving of salt is physical). This is similar to what I had explained about pupils' responses to the process of heating the solution in the aforementioned extract from the class group discussion. Whether getting back the solution of the salt after heating or getting the salt back after dissolution, the water itself was not considered. The teacher did not open a discussion about getting back the water, or any other substance going through a physical change (as the transcription shows). Therefore, when the water was discussed alone as a substance in the example of the evaporation of water, the pupils got confused and the ones who were supporting the view of physical change could not defend it strongly to convince others holding the opposite and incorrect view.

6.4.2 Evidence (signs) of chemical change

In addition to the ir/reversibility characteristic, the evidences (signs) of chemical change were vastly used by pupils to make the judgments about the kind of substance change. This criterion, similar to ir/reversibility, also seems to be a potential source of different conceptual difficulties. Probing into the pupils' difficulties that appeared throughout the focus group setting and the teaching suggest two problematic paths in understanding the chemical change in relation to the signs:

1. The participating pupils seem not to be aware of why the given signs (the change of colour, the rise of gas, the formation of precipitate, and the change of temperature) are the evidence of chemical change in the first place. The four, indeed, indicate the formation of a new substance because of chemical reaction; the fundamental attribute for any change to be chemical. I have referred previously to the absence of the criterion of the formation of a new substance from the pupils' reasoning (section 6.4.1.2), but the influence of this absence appeared and caused conceptual difficulties more evidently through the implementation of the four signs in approaching chemical change. In many incidents, the pupils were not able to recognise when to consider the rise of bubbles or change in temperature, for example, as signs of chemical change and when not to.
2. The participating pupils seem not to take into consideration the 'possibility' of these signs to appear. Generally, a given chemical change might happen with none of these signs noticed. In contrary, the pupils' talk reflects their thinking of a chemical change as necessarily showing one of these signs, and more radically, all four signs. , the

possibility implies that these signs might be observed in a given change, but they are not necessary to be considered as an evidence for a chemical change, as these can also be seen in a physical change. It primarily requires to know when to consider a sign as an evidence or when not to in relation to the formation/non-formation of a new substance.

The following extracts from the focus group discussion demonstrate the pupils' conceptual difficulties in dealing with the signs while determining the kind of change:

S₁: but in this experiment, bubbles rose (referring to the first dialogue sheet in which bubbles rise in a boiled water). We've said that the rise of bubbles is evidence of chemical change

S₄: bubbles are not always evidence. I mean when we learned, Miss- the air particles are there in the water. Also they are here

R: the air particles are in the water?

S₂: the air particles surrounding us, cos in the experiment, we've said umm-

R: she is saying they're rising. So to answer her, tell her what is inside the bubbles

S₄: inside the bubbles air, but it's umm-

S₃: inside the bubbles, cos...so it means Oxygen inside the bubbles...the heat breaks up the water into Hydrogen and Oxygen...

S₄: I didn't say it broke up. Cos if it broke up means a reaction happened and a new substance formed

S₃: we can get it back, Hydrogen and Oxygen will combine...

S₄:...liquid, water vapour... S₃: Hydrogen cos it's lighter... S₄: maybe Hydrogen cos... S₁: maybe carbon dioxide or oxygen... S₁: Carbon dioxide from reactions...

S₄: these bubbles are from the water. It's the same, but becous of the effect of the temperature, the gas formed

S₃: we've learned that change can be more than one, can be physical and can be chemical... (the talk goes on, to get to the change in temperature as evidence)

S₁: cos it reacted. The temperature changed and bubbles rose...

S₄: ...In this experiment, it's not considered evidence of chemical change, cos the rise of temperature didn't result from a reaction. It got higher from the benzene

S₁: but heat increases the temperature of the water...(the argument between the two goes on)..ok, still there are the bubbles

Following this unfinished argument on the rise of bubbles and the change in temperature as whether to be seen as an evidence or not for the discussed change, I asked directly:

R: why is the rise of bubbles considered evidence of chemical change?

S₄: cos a reaction happened. It's considered, but not in all cases a reaction happen. I mean gases come out when a chemical reaction happen. For example if we have sodium bicarbonate with vinegar,...and it produces carbon dioxide and....they will break up, break up together and the gas of...

S₂: ...it's not necessary that the chemical signs indicate a chemical change...

S₁: we've studied that the rise of bubbles or gas is evidence, cos a reaction happen-because of bubbles, gases produced

S₂: but not in all the cases...

It is obvious how the argument led by S₁ in these extracts shows the mistaken conceptions, and that led by S₄ shows the conceptions more compatible with the scientific view; a situation similar to what was noticed in the account of the reversibility criterion (section 6.4.1.3). In the last two extracts above, S₄ appears very convincing with the reasonable and scientific justifications that she was presenting. The rest of the girls in the group seem to be influenced by S₄'s argument and were supporting her more than S₁. However, none of them made a

valuable contribution in explaining the scientific conceptions apart from repeating some of the justifications presented by S₄. In fact a contribution like S₂'s utterance in the last extract; '...it's not necessary that all chemical signs indicate a chemical change...', also reflects a misunderstanding as she describes the signs as chemical, which points actually to the same main problem of S₁ who considers the four signs as always being the evidence of a chemical change. Moreover, when S₄ did not sound very convincing and could not defend her view strongly in the first extract (as happened when arguing about the reversibility), the other girls responded mistakenly and confusingly about the discussed point. The dialogue sheets, the group filled in, support this analysis, as the writings of S₁ and S₄ are very clear in reflecting their expressed opinions in the focus group, whereas, the other three accounts show unclear and confused views. Here are the samples of their writings, taking the roles of two girls; Sara and Madeline in the first scene:

(Writings of S₁)

Sara: the rise of gases can be evidence of a happening change, but what is the kind of the change???

Madeline: the happening change is chemical change and not physical and the evidence is the rise of gases as you've said...(the written talk goes on regarding the substance features)...but till now, we don't know the reason behind the rise of gases???

Sara: the reason can be the happening of a reaction between the water and the eggs or it can be because of the change in temperature

(Writings of S₄)

Madeline: Do you know the reason for these bubbles Sara? Or the heating has an influence?

Sara: yes cos hot water affects the movement of the water particles and it's increasing its movement, and with this increase, the bubbles form

Madeline: but are these bubbles evidence of chemical change?

Sara: no, they don't indicate a chemical change, but it's now in the boiling degree which is one of the physical features of the substance. So, it is a physical change and we can get it (masculine pronoun referring to the process of change) back to what it was

(Writings of S₃)

Sara: what is this rising, does it indicate the frying of the egg?

Madeline: I don't know, but don't you think because of rise in temperature. And I think we've studied something about. I think it's physical

Sara: No, Madeline, this is not physical change but chemical change cos the temperature is changing, and the physical is outward change of the substance

Madeline: wait. Chemical change is ...don't you think in this case there are physical and chemical changes?

Sara: right, maybe different changes, but I'm not sure. I might ask the teacher tomorrow

Madeline: maybe the bubbles rise because of the change in temperature, but the evaporation is physical and also chemical

Sara: Yeah, better to make sure

What I am arguing about here is that it was not only S₁ who was holding to different misconceptions or facing difficulties in getting to the scientific view. She was the most persistent and confident in defending these misconceptions. The other three girls were sharing some of her misconceptions but were less sure about them, and were more likely, therefore, to be convinced with the logical and clear justification provided by S₄. This brings us back, in fact, to the influence of the focus group setting, that I referred to at the beginning

of this section, concerning the unavoidable change of the pupils' thoughts due to the group interaction. What is more, I believe that facing the direct question, of why to consider those signs as evidence, may have influenced their thinking about the issue. It is not a difficult question to be answered, but it is vital to bring to the pupils' awareness the relation of these signs to the main characteristic of a chemical change of producing a new substance, which is expected to reduce the conceptual difficulties in using these signs to judge the kind of a given change. However, the teaching transcription does not show any incident in which the teacher asked such a question or raised this point. In introducing the issue of signs in the fifth lesson, the following exchange of talk took place:

T: ...there are also signs that help you to identify if there is a chemical change or not...
 S_a: changes in temperature?
 T: excellent. Maybe change in temperature...other signs?
 S_b: rise of gas and bubbles
 T: rise of gas and formation of bubbles. Good, other sign of...
 S_c: formation of precipitate
 T: formation of precipitate ^
 S_d: change of colour
 T: change of colour ^ Good...

Regarding the possibility point, again in introducing the signs, the teacher did not talk about the signs as 'possible evidence' although she wrote on the board the title of the topic as 'The possible evidence (signs) of chemical change' as displayed by the textbook. No discussion was opened regarding this possibility or when to consider a sign as evidence or not. However, there was one recorded incident in which the teacher talked about it in the context of the pupils presenting the signs observed in one of the reactions they did in the second experiment. The pupils talked about some signs that the teacher does not agree are observable in that reaction, and so she responded saying that:

T: ...So we have the signs of ...ok? I said (maybe she means her talking to the groups) it's not necessary to see all the signs. I might see one sign of chemical change only, and might not see any one. You get it? And might see two or more. Clear or not?
 S: clear

Over against this incident, there were different incidents of talk through which the possibility point seems to be discounted indirectly:

S_a: maybe this is because there is no precipitate? And no change in colour or temperature
 T: you didn't see a precipitate. You didn't notice change in temperature?
 S_a: no, that's...gases or what are these?
 T: rise of gases. Excellent. She didn't see such signs. She didn't observe a formation of a precipitate. she didn't observe a change in colour...and didn't notice the rise of bubbles of gas...

Furthermore, some incidents of group discussion concerning the second performed experiment also seem to reflect the mistaken uptake of this point. Here are small extracts of such incidents of talk:

(Discussing the step of adding some water to red phenol and calcium chloride)
 S₃: bubbles. Ha, bubbles of gas
 S₄: no, no, one sec. its colour S₃: it changed S₂: yeah it changed
 S₅: and bubbles ... S₁: isn't it like hot S₂: hot S₃: so this is exothermic ...

The teacher passed by the group and found out the mistaken sign of the bubbles, but she did not discuss it in relation to its implementation as an evidence, nor did she raise the point afterwards through whole classroom discussion:

T: you saw bubbles?

S₂: Yeah

S₄: but disappeared immediately

T: maybe those the air bubbles...during the shaking. If you take water and shake it...so you noticed them after a long period

S₄: but maybe don't considered maybe chemical change cos it's not necessary, I mean- - (silence)

T: well done (she leaves the group and goes away)

S₃: the rise of bubbles, erase it (from the observation sheet)

S₂: erase it

Subsequent to this incident, however, came the teacher's utterance that I displayed earlier, in which she explained that it is not necessary to see the four signs in a given chemical change. Here is another excerpt from the exchange of group talk that took place in the second step of the experiment, and which demonstrates more clearly the pupils' mistaken approach to the issue:

(Discussing the step of adding sodium bicarbonate to the previous mixture)

S₄: bubbles

S₃: bubbles of gas and there is precipitate. Put it on the sunlight, it will be clear. The colour got lighter

S₄: so the first thing the colour and the formation of bubble of gases

S₃: and a little precipitate and the temperature...

S₅: and bubbles ... S₁: isn't it like hot S₂: hot S₃: so this is exothermic ...

S_g: change of colour and rise of bubbles (to be written in the observation sheet)

S₄: and the formation of precipitate and temperature. Four changes, and the evidence all of these, that a chemical change happen. And that's it

This group discussion demonstrates quite clearly how the pupils are discarding the possibility of the signs indicating a chemical change as they are trying to attach all the signs of the discussed change to prove that it is a chemical one.

Nevertheless, no conceptual difficulties in relation to the sign of the formation of the precipitate were evident through the focus group discussion. This is partly because the pupils agreed over the kind of change in dissolving processes, as this type of change has been raised through the teaching in several incidents and the judgment on it was supported positively by the reversibility criterion as I have explained in the previous section. Moreover, the one incident of discussing this sign through the focus group setting came after the argument on the bubbles and temperature, and after I directed the question of why to consider the signs as evidence, for which S₄ provided the solid and reasonable justification I have already mentioned. This may have contributed to reducing the pupils' conceptual difficulties regarding this sign through the focus group discussion:

R: and the formation of precipitate, why it's evidence of chemical change?

S₃: cos now we've said that the chemical change produces a new substance. So the precipitate is the new substance

S₁: cos the precipitate didn't dissolve in water or in the substance. This is chemical change, cos I mean there is something got out of reaction

R: ...ok here...the water evaporates and the salt remains. The salt here, isn't it a precipitate?

S₄: a precipitate. But we can get the salt back to its initial state
R: Isn't the formation of the precipitate evidence of chemical change?
S₄: The precipitate. Right if there is a reaction and new substance formed
S₃: yeah a new substance...the features of salt didn't change, we can get it back
S₄: yeah normal, we can get it back

Regarding the sign of change of colour, it is also concluded that this point did not cause any conceptual difficulty during the group discussions through the teaching (this point was not raised through the focus group discussion). This can be justified by the teacher's contribution to explaining more than once that change of colour is not necessarily a sign of chemical change, as it can be also noticed in physical changes:

T: Colour, good...it's right that colour can be seen as a physical feature, but it's also coming within the chemical properties, So I wouldn't take it as a distinctive..

T:...the colour- I told you. Like the ice for example, what it's colour?...white. When it melts..it becomes like colourless...there is change in colour, but the change is...physical..if you brought a lemon juice and add it to tea...will be change in colour and this is...chemical change...

T: what's your evidence that it's a chemical change?
S_a: change in colour?!
T: change in colour-what's it? I want an obvious sign

The same can be heard during some of the group discussions through the teaching:

S₂: rise of bubbles and change in colour
S₄: but be careful, change of colour is not always evidence

A final point of discussion to be argued about here is the influence of the scientific information on the pupils' spontaneous thinking. Perceiving physical change in terms of the characteristic of the non-formation of a new substance can be seen as more spontaneous than the thinking that considers the scientific facts of the rise of bubbles and change in temperature as signs of chemical change. What can be noticed from the different discussed incidents is the dominance of those signs over some pupils' thinking, or as DiSessa (1988; 1993) would describe it as having a stronger cuing priority. Without those pieces of scientific information in their mind, it was possible that the pupils would not mistake the simple physical changes they have been asked about. This opens, in turn, our mind to the critical situation in which scientific information, when not being explained correctly and clearly, can, itself create mistaken conceptions that might even spoil more correct spontaneous thinking.

A summary of the pupils' understanding on the different issues discussed in this section (6.4) is offered in the concluding chapter (section 10.1.2).

6.5 Summary

In this chapter, I presented the results of the first case prior to the TI. The surface analysis demonstrated the dominance of the Authoritative approach over the CT practice. Further analysis using the framework revealed some general characteristics featuring Authoritative talk. However, different examples have shown differences in these characteristics' persistence. Hence, Authoritative talk has been labelled into different levels of high, mid and low. Moreover, the results pointed to the pupils' influence in supporting the authoritative practice of the teacher, and the influence of the 'empirical content' in reducing the authoritative level of the talk. In the light of examining indicators of learning, the results suggest that the Authoritative talk does not seem to support pupils' learning. Moreover, the results from the focus group discussion revealed different misconceptions and conceptual difficulties, indicating that the pupils do not have a solid understanding of the taught topic. Besides, the results illustrated a resonance between the pupils' conceptual understanding and difficulties and what happened in teaching.

The next chapter displays the analysis of this case from the second stage.

7 CHAPTER 7: ANALYSIS OF CASE ONE, STAGE TWO

This chapter also studies the case one by examining the data generated after the TI. It follows the structure of the previous chapter. It gives an account of the overall teaching approach (7.1), discloses the quantitative results of the 'surface analysis' (7.2), presents the detailed qualitative results of the 'synoptic analysis' (7.3), and ends with discussing the pupils' conceptual understanding (7.4) based on the data from the focus group setting.

7.1 The overall teaching approach

The subject of electric circuits in the grade nine Omani science curriculum is taught within a large group of topics including moving charges, designing an electric circuit, measuring devices, potential difference, resistance, series and parallel circuits and Ohm's law. Nine lessons were videotaped in this stage. For the analysis, however, the data of the first 5 lessons has only been used because of the following considerations:

- to match the number of the lessons videotaped and analysed for the topic of substance changes in the first stage;
- to include those lessons that involved the most of CT at this stage. In this regard, the first lessons included more CT than the last ones whose time was largely spent in performing practical activities.

The first lesson started with revision of the concept of dynamic electricity before focusing the talk on electric circuit. The teacher initiated, first, a general discussion about; where electric circuits can be found, their different kinds including both simple and complex, and the need of the circuit to be closed. She distributed then a number of chips that contain tiny electric circuits and asked the pupils to open a group discussion to identify any components they knew and to try to follow the route of the connection. At this stage, she was passing by each group and was exchanging talk about the given chips. This was followed by a whole class discussion about the main components of the electric circuit, as displayed by the textbook. The teacher also designed on the board a table of comparison between the components regarding their; name, shape, symbol and function. She then discussed few of these components throughout the remaining time of this lesson (wire, battery, resistance, electric key).

The teacher continued this talk in the second lesson by discussing the components of ammeter, voltmeter, galvanometer and rheostat. Based on some of this information, the teacher asked the pupils to draw a simple electric circuit and explain how the bulb would eventually work. Then, she announced five questions that she wanted the pupils to think of and offer their views on, to be recorded on the board and discussed. These are:

- How long does it take the bulb to light after the circuit is closed? Is it long, short or instant?

- What kind of energy is produced in the bulb?
- What is the source of this energy?
- How does this energy reach the bulb?
- Describe the current movement in this circuit and specify its direction.

She started listening to the pupils' answers to these questions one by one, and documented the main views on the board. By the end of the lesson, the discussion about the fourth question was going on which had already consumed a long and rich part of the debate.

In the third lesson, the teacher continued managing the debate about the fourth question, which extended then to the fifth one. Different opinions had been discussed in detail in the first half of the lesson. In the second half, the teacher introduced the first activity, which could help pupils reach scientific answers to the first two questions. She asked the pupils to design a simple circuit and observe the lightness of the bulb and the kinds of produced energy. She listened to all groups' observations before asking them to repeat the same practical activity, but with long wires this time, and to observe what happens. The lesson ended after this activity.

The fourth lesson started with a discussion of the pupils' explanation of the instant glow of the bulb in the second activity. This discussion extended to different views about the movement of the current and the working of electric circuit in general. The pupils were intended to present more opinions, but the teacher stopped the discussion and made it clear that it was time to present the scientific account. Consequently, she moved the attention to a flash display of the electric circuit and told how it works. In this display, she explained about the source of the charges, the nature of their movement when the circuit is open or closed, direction of the movement and other details concerning the working of electric circuit.

This explanation and a review of what had been presented continued in the fifth lesson as well. The teacher wanted then to confirm the scientific views by using an analogy presented in the second handout of the TI (Bakery-Supermarket analogy, appendix 4). She described the analogy and mapped out its links to the components of electric circuit and how it works. Then, she guided the talk to the concept of current intensity; its definition, symbol, and method of calculation and measurement. The same kinds of details were also presented for the concept of potential difference. The lesson ended with the discussion of the method of connecting the electric devices ammeter and voltmeter in the electric circuit.

In the following lessons, different practical activities were conducted that started with how to take readings from these devices and ended by taking such readings in series and parallel circuits through the application of Ohm's law. In her teaching intervention, therefore, the teacher chose to outline some of the basics of electric circuit and pupils' thoughts of how it works, and then led the discussion to the scientific account.

Table 7.1 offers a general description of the content of the five analysed lessons.

Lesson	The content
1- Electric circuit: kinds and components	<i>Review of the concept of dynamic electricity - pupil's views of the electric circuits; where to be found and how to be considered simple or complex-group work and whole class discussion about what components given chips contain - comparison among some electric components</i>
2- How does the electric circuit work? (1)	<i>Comparison among other components of the electric circuit– designation of a simple circuit – pupils views of the first four questions explained earlier</i>
3- How does the electric circuit work? (2)	<i>Pupils' views of the fourth and the fifth questions- conducting a practical activity of electric circuit with short wires – discussing the pupils' observations – conducting a second activity with long wires</i>
4- How does the electric circuit work? (3)	<i>Pupils' explanation of the observations from the second practical activity – a flash display of how the charges move and how the bulb lights; explaining its constituents, discussing the pupils' observations of the display and presenting the scientific account</i>
5- How does the electric circuit work? (4) – Current intensity & potential difference	<i>Review of the transformation of energy in the simple electric circuit – a display of the (Bakery-Supermarket analogy) and relating it to the electric circuit – comparison between the two concepts of 'current intensity' & 'potential difference' regarding their; definition, symbol, measuring device, equation and unit of measure and the method of connection in electric circuits</i>

Table 7.1: Description of lessons in C1, S2

7.2 Results from the ‘Surface Analysis’

This section addresses the following RQ (refer to section 5.1) following the TI (b):

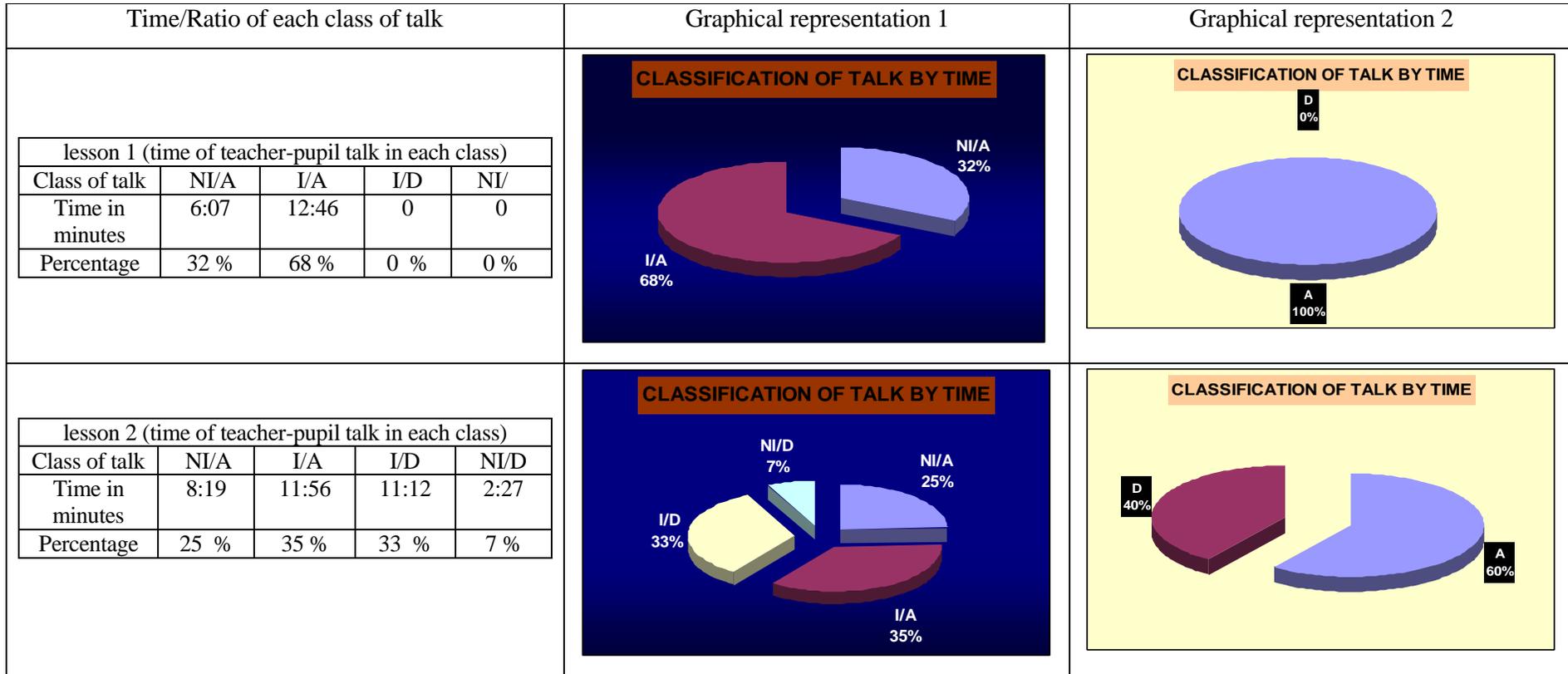
1.1b What classes of communicative approach does the recorded CT exhibit?

Again, in this stage, the teacher initiated the entire exchanged CT, and no talk was initiated by pupils. However, this stage witnessed a big change in the types of the exchanged talk. The results indicate that out of the five analysed lessons, three demonstrate high percentages of Dialogic talk. In fact, Dialogic talk prevailed in the 90% of the talk time in lesson three. On the other hand, the results point to the total absence of Dialogic talk from the first and the fifth lessons. In the first lesson, the teacher was attempting to reduce her control but without any success in achieving a Dialogic CA. In the fifth lesson, the teacher made it explicit that she was worried about exceeding the time allocated to the teaching of the topic of electric circuit, and, thus, dedicated the lesson to presenting the scientific account only.

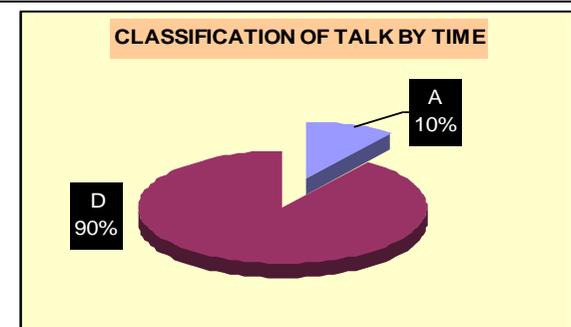
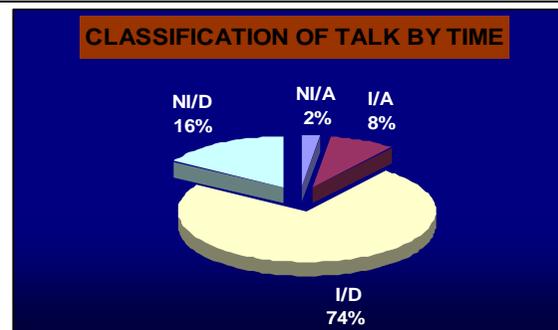
Figure 7.1 offers a review of the surface analysis results of the lessons at this stage, including:

1. The Sum of time and ratio of each class of talk observed during each lesson;
2. Graphical representation (1) of the ratios of all observed classes of talk;
3. Graphical representation (2) of the ratios of Authoritative and Dialogic types

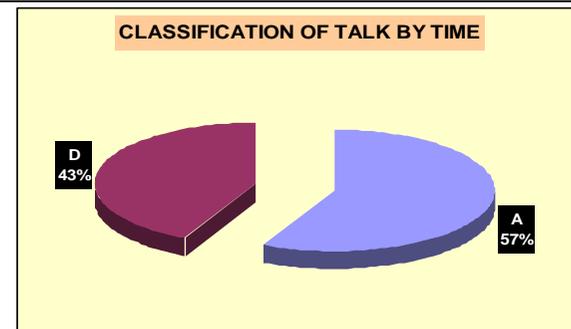
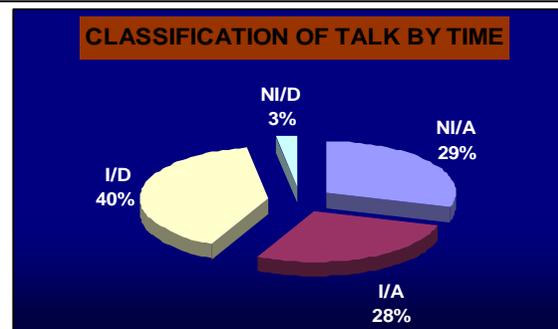
Figure 7.1: The 'surface analysis' results of C1, S2



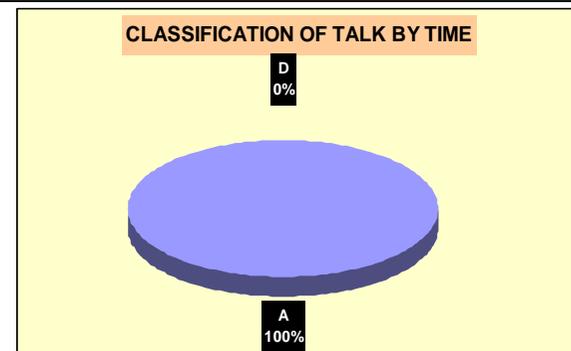
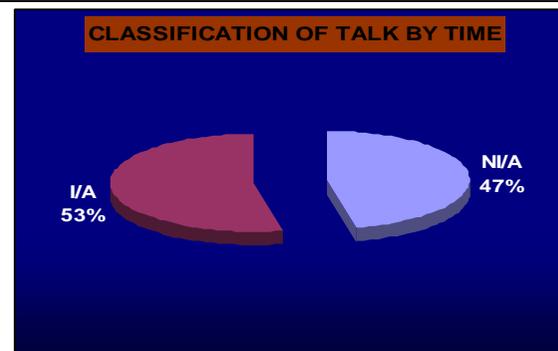
lesson 3 (time of teacher-pupil talk in each class)				
Class of talk	NI/A	/A	I/D	NI/D
Time in minutes	0:30	1:50	16:00	3:37
Percentage	2 %	8 %	74 %	16 %



lesson 4 (time of teacher-pupil talk in each class)				
Class of talk	NI/A	/A	I/D	NI/D
Time in minutes	9:04	8:34	12:21	0:51
Percentage	29 %	28 %	40 %	3 %



lesson 5 (time of teacher-pupil talk in each class)				
Class of talk	NI/A	/A	I/D	NI/D
Time in minutes	14:38	16:38	0	0
Percentage	47 %	53 %	0 %	0 %



7.3 Issues arising from the 'Synoptic Analysis'

This section addresses the following RQs (refer to section 5.1), following the TI (b):

1.2b What features of Authoritative and Dialogic communicative approaches are revealed by the implementation of the analytical framework?

2.1b What indicators of the potential of Authoritative and Dialogic communicative approaches to support pupils' learning are revealed by the implementation of the analytical framework?

The Dialogic talk captured more interest through the synoptic analysis of this stage due to two considerations. First, this type attracted more attention through the 'deep analysis' as the application of the framework contained slightly more and, most importantly, longer examples of Dialogic talk than Authoritative one. Secondly, the synoptic analysis of the first stage has covered the characteristics of the Authoritative type as the recorded CT was dominated by it. Nevertheless, the Authoritative examples of the first lesson have been used to tackle the issue of:

- How has the teacher practiced the transition towards the practice of more Dialogic talk? (RQ 1.2b)

Following this are the results of the synoptic analysis of the Dialogic talk. The detailed analysis of different examples of this type demonstrated different characteristics specific to the context of each of these examples. Bringing these characteristics together has resulted in raising the following issues of:

- What has constituted the Dialogic talk? (RQ 1.2b);
- What has influenced the level of the Dialogic talk? (RQ 1.2b);
- How does the Dialogic talk seem to support/not support pupils' learning? (RQ 2.1b)

It is worth mentioning that the Authoritative examples in this stage reflect the same detailed characteristics described in the first chapter. However, there is a difference of levels between the examples of this stage and those of the first stage. The examples of the first stage were dominated by Authoritative talk of high level, whereas, the authoritative examples of this stage reflect the mid and low levels (refer to fig.6.2) as the features that characterise the Authoritative talk seem less evident and less persistent.

7.3.1 How has the teacher reduced her control over the talk?

The entire talk of the first lesson was classified as Authoritative. Two long examples from this lesson has been analysed through the application of the framework. The teacher, who practised high authority in the first stage, was trying to reduce her control by implementing a number of strategies in this lesson. However, she did not succeed in exchanging a kind of talk that may be classified as Dialogic according to CA. In fact, she was hanging between

authoritative and dialogic practices while guiding the talk, as the results below prove.

The analysis of these examples in this section are used, therefore, to explain the teacher's attempt to reduce her control by focusing on the implemented strategies and the characteristics of the resulted practice that show both authoritative and dialogic features.

7.3.1.1 Implemented strategies

In her attempt to practise less control over the talk, the teacher implemented the following strategies:

1. Setting the purpose of the talk as exploring pupils' views

The purpose of the Interactive/Authoritative parts of the two analysed examples was to explore pupils' views; the purpose usually assigned to the Dialogic type of talk. In the first two parts of example one, the teacher sought to explore the pupils' views about the places in which electric circuits can be found in the first part, and the difference between simple and complex circuits in the second one. In the second example, she listened to the pupils' opinions about the definitions of electric circuit:

The main initiation	Purpose of the talk	Example
Where do we find electric circuits?	Exploring pupils' views	Ex.1, Part 1
What's the difference between the simple circuit and the complex one? And what do I mean by the word complex? What does complex mean?	Exploring pupils' views	Ex.1, Part 2
Who defines the electric circuit?	Identifying pupils' views of a scientific concept	Ex.2

Table 7.2: Purposes of I/A excerpts in Les.1 in C1, S2

In these two examples, the teacher, in fact, was attempting to practise the basic type of Dialogic talk of identifying and listening to the pupils' opinions as explained in the TI. Guiding the talk towards this purpose is an advantage towards more verbal and intellectual participation and control over talk by the pupils.

2. Setting the content to include personal views and to relate to everyday experiences

Related to the purpose, of exploring pupils' views, is the shaping of the content in a mixture of personal and scientific views about the discussed subject matter. The content of different Interactive/Authoritative examples demonstrates this feature:

Example of I/A	Content
I/A, Ex.1: Part 1 I/A, Ex.1: Part 2 I/A, Ex.2	Personal/Scientific views of Theoretical Scientific subject matter
I/A, Ex.1, Part 3	Personal/Scientific views of Theoretical <u>Everyday</u> /Scientific content

Table 7.3: Content of I/A excerpts in Les.1, C1, S2

Nevertheless, the teacher tried to reinforce her orientation towards dialogic practice by initiating a talk about everyday experiences that are related to the discussed scientific issue as the content of 'Ex.1, Part 3' in table 7.3 shows. In this part, the teacher initiated the talk to confirm the scientific view regarding the simple/complex circuit by relating it to an everyday experience when asking:

T	Which circuit is more complex; the one that links the street lamps or the one inside the laptop?	Ex.1, Part 3
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This means that the content has supported a dialogic practice as it is open to pupils' personal views regarding the scientific subject matter on one the hand and everyday experiences on the other.

3. Listening to the pupils' incorrect views without disapproving of them

In different turns through this lesson, the teacher was trying to keep a neutral position in responding to pupils' contributions of incorrect answers. She rarely refused or disapproved the pupil's incorrect responses directly and immediately as she was doing in the first stage. Here are some of the examples demonstrating such behaviour:

7.T	You mean within the device?	Ex. 1 Part 1
8.S ₂	Yes, inside the device	
9.T	Ok, sit down, thanks	
12.S ₄	Simple, might be connected to one device	Ex. 1 Part 2
13.T	Connected?	
14.S ₄	With one device. The complex contains more than one device	
15.T	You mean, the simple contains one device and the complex has more than one. Ok	

23.T	Which circuit is more complex; the one that links the street lamps or the one inside the laptop? Yes S ₇	Ex. 1 Part 3
24.S ₇	The one for the street lamps	
25.T	Street lamps' circuit is more complex.	

4. Elaborating the pupils' presented views

One of the distinctive features that characterised the low-level Authoritative talk in the examples of this lesson is the teacher's continuous elaboration of the pupils' answers. By doing so, the teacher could exchange longer talk with each pupil in order to bring out pupils' thoughts by giving them the chance to explain and justify their opinion. Here are three excerpts from the three parts of the first example, respectively, showing how the teacher followed this strategy:

3.T	Is it just inside the electric devices we can find electric circuits? Think about it	F I	
4.S ₂	No, we find it outside	R _{2,1}	
5.T	Where outside?	F	E _L
6.S ₂	Outside. In the classroom for example, I mean (...?)	R _{2,2}	
7.T	You mean within the device?	F	E _L
8.S ₂	Yes, inside the device	R _{2,3}	

9.T	Ok.	F	
-----	-----	---	--

11.T	What's the difference between the simple and complex circuit ? And what do I mean by the word complex? What does complex mean?	I	
12.S ₄	Simple, might be connected to one device	R _{4,1}	
13.T	Connected?	F	E _L
14.S ₄	With one device () The complex contains more than one device	R _{4,2} , F R _{4,3}	E _L
15.T	You mean, the simple contains one device and the complex has more than one. Ok If I brought a big device like TV. Inside it, there is also a circuit. This circuit inside is simple or complex and it's inside one device?	F F	C ₀ E _L
16.S ₄	Complex	R _{4,4}	
17.T	Why complex?	F	E _L
18.S ₄	Cos it embodies more than one device	R _{4,5}	
19.T	More? In the TV for example or the fridge or ...	F	E _L
23.T	Which circuit is more complex: the one that links the street lamps or the one inside the laptop? ...	I	
26.S ₈	...The one for the laptop is more complex	R _{8,1}	
27.T	Why?	F	E _L
28.S ₈	Cos the laptop – is complex. Why? Cos there is internet and circuits. I mean, yeah the circuit is small but its components are more	R _{8,2}	

This strategy appears very clearly through the patterns of discourse of these examples:

I/A: ...I-R_{2,1}- E_L-R_{2,2}- E_L -R_{2,3}-C₀-I-R₃-E_v (Ex.1, Part 1)

I/A: I-R_{4,1}-E_L-R_{4,2}- E_L -R_{4,3}- C₀, E_L-R_{4,4}- E_L-R_{4,5}- E_L-R₅-E_v (Ex.1, Part 2)

I/A: I-R₇-C₀-I-R_{8,1}- E_L-R_{8,2}-E_v (Ex.1, Part 3)

These patterns are different from those of most Authoritative examples analysed in the previous chapter. However, they are very similar to the ones noticed in the Dialogic excerpts of talk and will be clear in the following sections; one initiation with many responses and elaborative or comment follow-ups, and the absence of evaluative follow-ups until the very end of the excerpt.

5. Inviting different or multiple opinions

In the incidents where the teacher was listening to a certain opinion, elaborating and commenting without evaluating it, she was, sometimes, inviting the class to comment on what had been said. Through such behaviour, she was moving the control to pupils to evaluate the presented view before she does so. Here are two excerpts from the first and the second parts of example one, showing the teacher calling for an 'evaluating' opinion by asking; 'What do you think?':

8.S ₂	Yes, inside the device	R _{2,3}
9.T	Ok, sit down, thanks. What do you think? She said it's necessary to be within the electric device. S ₃	F I
10.S ₃	Maybe the electric device is connected to the circuit	R ₃

24.S ₇	The one for the street lamps	R ₇
25.T	Street lamps' circuit is more complex. What do you think?	F, I
26.S ₈	The one for the laptop is more complex.	R _{8,1}

In these two excerpts, the teacher neither denies nor evaluates the opinions presented by S₂ and S₇, in the first and the second parts respectively. Instead, she moves the control to the rest of the class by inviting them to comment on these contributions. Accordingly, S₃ in the first excerpt, and S₈ in the second, provide different views and, therefore, contribute to the evaluation of S₂' and S₇' opinions. By asking for another opinion, hence, the teacher reduced her control over the talk. She did not evaluate the incorrect views but gave pupils a chance to think about those views and provide the correct ones without the need for her to do so.

In other incidents, she was just inviting the class to offer their opinions without asking the pupils to comment on each others' ideas. Example two shows the teacher trying to commit herself to take different opinions without really succeeding in keeping the neutral position of not evaluating them. This means that she was trying to implement the strategy of listening to multiple opinions to support a dialogic practice as the following excerpt demonstrates:

1.T	Now, who defines electric circuit?...	I
6.S ₁	...It's an electric circuit that connects any device with electricity	R _{1,3}
7.T	Still, you're not saying the definition I'm looking for. Ok. No problem. Let's take opinions	F I
8.S ₂	It's a group of devices connected together to carry (move) the electric circuit	R ₂
9.T	A group of devices connected together to carry (move) the electric circuit Another opinion	F I
10.S ₃	It's a group of main components connected with wires	R ₃
11.T	A group of main components connected with wires. Still I want a precise articulation	F I

6. Asking questions of high cognitive level

A very fundamental attribute, in reducing her control in the discussed examples, was the high quality of the questions that the teacher was directing to the class through the initiation move as well as the elaborative follow-ups. The teacher started the three parts of the first example by asking questions that stimulate the pupils to operate with cognitive processes of high level:

Where do we find electric circuits?	H: CP of 'Understand; infer'	Part1
What's the difference between the simple circuit and the complex one?...	H: CP of 'Analyse; differentiate'	Part2
Which circuit is more complex; the one that links the street lamps or the one inside the laptop?	H: CP of 'Apply; Implement'	Part3

Table 7.4: Cognitive processes of questions in Ex.1, Les.1, CI, S2

Through the elaboration moves, she continued to direct questions of high cognitive level by asking the pupils to explain, justify, analyse and evaluate. The quantitative representation of the quality of the questions of the first example demonstrates this feature:

Class of talk	Question (Cognitive level)	
	Low	High
I/A: Ex.1, Part 1	1	4
I/A: Ex.1, Part 2		4
I/A: Ex.1, Part 3		3

Table 7.5: Quality of questions in Ex.1, Les.1, CI, S2

7.3.1.2 Characteristics of the resultant talk

It has been mentioned earlier that the authoritative attitude of the teacher has interfered with her attempt to practise Dialogic talk, which led to the classification of the talk in this lesson as Authoritative despite the implementation of six explained strategies (section 7.3.1.1). This interference had resulted in a practice in which the teacher appears to be hanging between authoritative and dialogic behaviours. The aforementioned strategies not only illustrate how the teacher could lower the authoritative level of the talk and increase the dialogic one, but also show the resultant characteristics of this type of talk. These characteristics feature in the purpose, content, kinds and pattern of moves, and the quality of questions of this talk. There is a need, therefore, to shed light on the characteristics that led, eventually, to the judgment of labelling the talk as Authoritative. In general, the authoritative attitude of the teacher manifested itself very clearly through:

1- The evaluative and elaborative follow-up moves

The persistence of the teacher's authoritative attitude, to interrupt her dialogic attempts, can be spotted in her oscillating behaviour while listening to pupils' opinions, in moving between evaluating them or not providing an evaluation. Although for most of the time, during the exchange of talk in the three parts of the first example, she did not disapprove the incorrect opinions (strategy 3, section 7.3.1.1), yet she could not resist to approve the correct ones for which she was providing immediate praise. The same excerpts, that had demonstrated the absence of the disapproving voice of the teacher for the incorrect answers and showed her calling the pupils to practise the evaluative role, also demonstrate how the teacher was approving instantly the correct views:

9.T	Ok, sit down, thanks. What do you think? She said it's necessary to be within the electric device. S ₃	F I
10.S ₃	Maybe the electric device is connected to the circuit	R ₃
11.T	Excellent. Maybe this device is part of an electric circuit...	F

25.T	Street lamps' circuit is more complex. What do you think?	F, I
26.S ₈	The one for the laptop is more complex...	R _{8,1}
29.T	...Yeah, excellent. Cos the components are several and various. For the street lamps, it's the same component...	F

12.S ₄	Simple, might be connected to one device...	R _{4,1}
20.S ₅	...Maybe in the simple circuit, the components are less and more in the complex one	R ₅
21.T	Excellent...The simple circuit as your friend has said has few components whereas the complex circuit is distinctive that it has many components.	F

This instant and strongly expressed agreement, which the teacher was providing for the correct views, has contributed to reducing the dialogic feature because it has not allowed a dialogue involving the contradictory opinions to take place. It has not allowed the pupils to

think about the different opinions presented in the class and to open a debate about them. On the other hand, such behaviour indicates that the teacher's interest was directed to get the scientific view and once a pupil offers it, she confirms it instantly. The teacher's desire to lead the talk in this direction has also appeared in the elaboration follow-up. Going back to the examples about the strategy of elaboration (strategy 4, section 7.3.1.1) demonstrates that the teacher was elaborating the correct views or the ones close to the desired view with the aim of revealing the scientific explanation or developing the partly true views in relation to the exact scientific ones.

It is true that the teacher adopted the purpose of exploring pupils' views and asked for different opinions as strategies that have reduced her control over the talk. However, directing the talk towards the scientific point of view is a fundamental characteristic that typified Authoritative talk. In fact, the aforementioned examples demonstrating strategies and behaviours in reducing the authoritative practice, and others illustrating the teacher's intellectual control over the talk, indicate the authoritative-dialogic alternating behaviour indirectly. However, the second example, which has appeared in the teacher's utterances through the initiation and the follow-up moves, illustrates this alternating behaviour directly and clearly; as the following utterances show:

1.T	Now, who defines electric circuit?...	I
3.T	... We don't want details. As a general definition, It's what?...	E _v I
7.T	...Still, you're not saying the definition I'm looking for. Ok. No problem. Let's take opinions...	E _v I
9.T	...A group of devices connected together to carry (move) the electric circuit Another opinion	C ₀ I
11.T	...A group of main components connected with wires. Still I want a precise articulation	E _v I

These utterances show the teacher trying to maintain a neutral position in responding to the pupils' suggestions for a definition of electric circuit by announcing in turn 7: 'No problem, let's take opinions' and asking in turn 9 for 'Another opinion'. However, these utterances could not prevent the teacher from revealing her evaluative voice that can be heard quite aloud in her sayings; ' Still, you're not saying the definition I'm looking for' (turn 7) and ' Still I want a precise articulation' (turn 11). Therefore, although the teacher in this exchange of talk has lowered her control level by asking for and taking multiple opinions, Still, the evaluative move, characterising Authoritative talk, dominates the follow-ups of this example; as the pattern of discourse and the quantitative representation illustrate:

Ex.2, I/A: I-R₁₋₁-E_v-I-R_{1.2}-E_v-R_{1.3}-E_v-I-R₂-C₀-I-R₃-E_v-I-R₄-E_v

Class of talk	Follow-up		
	E _v	C ₀	E _L
Ex.2: I/A	5	1	

2- Non-Interactive communicative approaches

The authoritative orientation of the talk was also confirmed by the utterances of the teacher through Non-Interactive Authoritative approaches. It has been previously explained that Interactive approaches served the purpose of identifying and exploring the pupils' views, and their content included pupils' personal and scientific views sometimes and everyday experiences other times (section 7.3.1.1). However, the Non-Interactive approaches indicate that although the teacher was exploring the pupils' views, yet her focus was directed to the scientific ones. Therefore, the content included scientific views only and its purpose was to review, confirm or develop these views. The characterisation of the purpose and the content of these Non-Interactive approaches- through the application of the framework, demonstrate this feature:

The utterance (Non-Interactive)	Purpose of the talk	Example
Maybe this device is a part of an electric circuit. I might find the electric circuit outside also, outside the electric device...I mean, it might be internal inside the device or external...	Reviewing/confirming the scientific views	Ex.1, Part 1
The simple circuit... has few components whereas the complex circuit... the important thing I must ensure in the circuit is a closed path that charges or dynamic electricity move through...	Reviewing/confirming the scientific views	Ex.1, Part 2
Not a closed circuit. A closed path that charges are moving through. The important thing here... is a path that guarantees the movement of electric charges. But the concept of the circuit has more than this....	Developing the scientific concept	Ex.2

Overall, it appears that the teacher used the shift from Interactive to Non-Interactive approaches to make some of the pupils' views including scientific ones available before controlling the task of reviewing, confirming and presenting the scientific account. As the Interactive approaches showed dialogic features, the Non-Interactive ones were dominated by authoritative practice.

Because of the attempts to show a more dialogic approach, the following lessons witnessed many episodes of talk that were classified as Dialogic. The following section presents the results of the synoptic analysis that characterises the Dialogic talk.

7.3.2 What has constituted the Dialogic talk?

Coding the results from the application of the framework to analysing the Dialogic examples of talk has generated the following categories and sub-categories in describing what has constituted the Dialogic talk.

7.3.2.1 The substitution of the evaluative position of the teacher with a neutral one

A very distinctive feature that differentiates a Dialogic excerpt from an Authoritative one is the absence of the evaluative voice from the teacher's contributions of the initiations and

follow-ups. Alternatively, we find the teacher taking a neutral stance in responding to the pupils' contributions. This stance can be followed through:

a) The Follow-up moves

In the entire Dialogic examples, the teacher was neither approving nor disapproving the pupils' presented views. She was just commenting by repeating, restating or rephrasing them. The quantitative representation of the types of the follow-ups illustrates the total absence of the evaluative move in favour of the comment one (table 7.6):

I/D Excerpt	Follow-up		I/D Excerpt	Follow-up	
	E _v	C _o		E _v	C _o
Les.2 , Part 1	0	3	Les.3, Ex.2, Part 2	0	4
Les.2 , Part 2	0	2	Les.3, Ex.3	0	3
Les.2 , Part 3	0	2	Les.4 , Part 1	0	1
Les.2 , Part 4	0	4	Les.4 , Part 2	0	1
Les3. Ex.1	0	5	Les.4 , Part 3	0	1
Les3. Ex.2, Part 1	0	1			

Table 7.6: Comparison between E_v and C_o in I/D excerpts, C1, S2

On the whole, it can be said that the teacher used the follow-up comment to perform two divisions of functions: a) to direct the attention of the class to the presented ideas, give these opinions value and encourage others to also speak out their thoughts; and b) to give the signal that the participation of a certain pupil or the discussion on a certain opinion should stop at that point. Deeper exploration of the different examples suggests three main levels in which the comment move has been practised to perform two above-mentioned functions:

- At the simplest level, the talk was taking the sequence of (I-R-C₀) that repeated with each pupil offering her point of view about a certain question (I-R₁-C₀-R₂-C₀...). This means that in practising Dialogic talk, the teacher was listening to a certain opinion without agreeing or disagreeing with it. Instead, she was trying to provide a neutral comment that gives the impression that the view might be correct and would be taken into consideration. The excerpt below (Les.2, Part 1) shows this feature simply and directly as reflected by its pattern of discourse (I-R₃-C₀-I-R₄-C₀):

9.T	...What forms of energy are given out by the electric bulb?	I	
10.S ₃	Light	R ₃	
11.T	Light (B), other opinion? (B: T writes on board)	F, I	C ₀
12.S ₄	Light and heat	R ₄	
13.T	Light and heat (B)	F	C ₀

- At the second level, the teacher was asking the pupils more questions on the views they were presenting. Accordingly, the talk was taking the sequence of (I-R-E_L-R-C₀) that went on with one pupil at a time. This means that in practising Dialogic talk, the teacher was listening to a certain opinion and elaborates it for a certain purpose (e.g. diagnosing, clarifying) before commenting on it. Without any evaluation of the first opinion, she might then moved on to a second opinion to do the same and so on. Here is a small

excerpt (Les.2, Part 2) demonstrating this sequence through the pattern of (I-R_{7.1}-E_L-R_{7.2}-C₀):

14.T	Now, what's the source of this energy? ...	I	
21.S ₇	...From the things inside the resistance	R _{7.1}	
22.T	Comes from things inside the resistance, what's inside the resistance?	F	E _L
23.S ₇	(...?) From the wires inside the bulb	R _{7.2}	
24.T	So you say, the energy comes from the wires inside the bulb.	F	C ₀

- At the third level, the teacher was further elaborating one pupil's view by questioning her successive responses, which resulted in longer exchanges of talk with each pupil. Consequently, the teacher's neutral comment on the pupil's view (s) comes at the very end of the Dialogic excerpt after an extended pattern of discourse (I-R-E_L-R-E_L-R...-C₀). Through the comment move in this situation, the teacher comments on the main contribution of the pupil that gives a general idea about her view and may also clarify its resemblance to or difference from other presented views. The excerpt below (Les.2, Part 4) shows the teacher elaborating one pupil's view before commenting on it at the end of the excerpt (I-R_{10.1}-E_L-R_{10.2}-E_L-R_{10.3}-E_L-R_{10.4}-E_L-R_{10.5}-E_L-R_{10.6}-C₀):

47.T	Yes S ₁₀ (what do you think)	I	
48.S ₁₀	The battery gives an electric energy and it passes through the wires #	R _{10.1}	
49.T	How does it pass it through the wires?	F	E _L
50.S ₁₀	Cos the wires are connected to the electricity, the electrons will move through	R _{10.2}	
51.T	You said that the battery gives the circuit an electric energy, how?	F	E _L
52.S ₁₀	Cos it has chemical substances that help producing an electric energy. So the electrons will move through the wires till they reach the bulb	R _{10.3}	
53.T	Ok, I agree that the battery gives the circuit electric energy. Then you said the electrons will move through the wires. Where is the link between them?...	F	E _L
54.S ₁₀	Cos everything in life has energy, so the energy in the battery will move through the wires #	R _{10.4}	
55.T	So the energy has the ability to move through the wires?	F	E _L
56.S ₁₀	Yeah, it moves yeah	R _{10.5}	
57.T	Ok, why did you say the charges here?	F	E _L
58.S ₁₀	Cos the energy is made up of charges	R _{10.6}	
59.T	Energy is made up of charges. Let's write your answer. And then the energy will move through the wires. The energy has the ability to move and so ...	F	C ₀

It is worth mentioning that some episodes did not follow the exact sequence of one of the three patterns, but showed a mixture of the three (e.g. when more than one pupil were participating in explaining a certain view or when one pupil was presenting more than one view). Nevertheless, the meaning and the function of the comment move can be discussed within the role it played in the three described levels.

b) Non-Interactive approaches: In most of the incidents of taking the pupils' views on a particular point, the teacher ended the Interactive/Dialogic parts by reviewing those views through Non-Interactive talk. In such incidents, she was controlling the talk verbally but not intellectually because she was neither presenting a certain scientific view nor evaluating the pupils' views. Through these Non-Interactive approaches, she was carrying on her neutral position while listening to the pupils' thoughts and opinions by neither approving nor

disapproving them. In fact, the purpose of all the Non-Interactive/Dialogic excerpts that have been characterised in this stage using the framework was of 'reviewing the pupils' views'. This means that the teacher used the Non-Interactive approaches to summarise the presented opinions and/or to explain the thoughts offered by some pupils in an attempt to bring them to the awareness of the whole class. In doing so, she abandoned the evaluative role while judging these views in favour of correct or scientific one, and played a neutral role while not taking the side of any of them. Here are two of many excerpts (Les3, Ex.1 & Ex.2, respectively) that demonstrate the neutral position of the teacher, which appeared through the Non-Interactive/Dialogic parts:

11.T	S ₃ is saying that the current starts from here, passes, passes, passes till it reaches the bulb and lights. Also the positive charges but don't light up the bulb. Let's write S ₃ 's answer. So, the path of the current as she said: (B) -Starts from the negative pole of the battery till it reaches the bulb and completes its round. -The positive charges start from the positive pole.	C ₀
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33.T	All the positive and negative charges pass. That's enough for now. We've heard different opinions. Some are saying that the battery is the source of the charges and passes these charges to the wires. And the wires are conductive of the movement and so the bulb lights. This is basically the opinion of S ₅ , but S ₇ said No. the wires have charges...	C ₀
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7.3.2.2 The openness of the talk to the pupils' thoughts

All the Dialogic examples were built on the pupils' opinions. In some examples, these opinions appear to be discussed in more depth than in others. However, whether these opinions were explored superficially or discussed in detail, the talk was still open to the pupils' thoughts to some extent. This openness can be easily demonstrated through:

a) The purpose of the talk: The analysis by the framework illustrates that the talk in all the Dialogic examples has been exchanged to serve one of the following three purposes:

- Exploring pupils' views (e.g. Les.2, Parts 1, 2, 3 & 4)
- Challenging pupils' ideas (e.g. Les.3, Ex.2, Part 2 & Ex.3)
- Justifying scientific observations by using pupils' ideas (e.g. Les.4, Parts 1, 2 & 3)

b) The content of the talk: Although the discussed content of these examples included both theoretical and empirical scientific subject matter of different details regarding the electric circuit, yet this subject matter was discussed in the light of the pupils' views. Accordingly, the content of all Dialogic examples included 'Personal views of theoretical and/or empirical scientific subject matter'.

c) The initiation move: The openness of the talk to the pupils' thoughts through this move appeared at different levels:

- At the first level, the teacher was asking for pupils' views. Right from lesson two, she made it clear that she wanted to hear the pupils' ideas regarding the five questions referred to in the overall teaching intervention (section 7.1). These questions appeared as main initiations that guided long exchanges of Dialogic talk:

1.T	...you said that when closing the circuit, the bulb lights? I wanna know, since I close the switch till the bulb lights, how long it takes? Does it take a short period of time or a long one? Or will it light instantly? Yes S ₁	Les.2, Part 1
9.T	What forms of energy are given out by the electric bulb?	Les.2, Part 2
14.T	Now, what's the source of this energy?	Les.2, Part 3
27.T	Ok, the next question, how did the energy come to the bulb?	Les.2, Part 4
5.T	Ok. I want to describe how the electric current moves in the circuit. This current that you're talking about, that it moves in the electric circuit. Describe it, where does it start from? What does it pass through? And is it definitely that this current moves through the all parts of the circuit or just through certain parts of the circuit?	Les.3, Ex.1

- At the second level, she was stimulating the pupils to present more ideas about these questions by asking continuously for other opinions, as the following initiations illustrate:

3.T	Anyone has another opinion? S ₂	Les.2, Ex.1,
5.T	Any other opinion?...So no one is saying after a long period?	Part 1
1.T	...Does anyone have another opinion? Let's hear S ₅	Les.3 Ex.2
19.T	...What do you think? She is telling us that the charges are coming from the wire? What do you think? ()	
21.T	...S ₇ , I heard you saying something and then you stopped, what do you think?	
11.T	What do you think S ₂ ?	Les.4, Part 4

Here, the teacher is inviting the pupils to speak out their thoughts and repeat them in the attempt to make the whole class aware of them. She is encouraging pupils to think about different possibilities to answer certain questions. She is also supporting hesitant students to say what they think.

- At the third level, the teacher was stimulating the pupils to offer views that contradict the ones presented already, as the following utterances show:

19.T	Is there anyone who disagrees with the description of the path of the current?	Les.3, Ex.1
15.T	Who is the brave one who disagrees with S ₅ ? () You're disapproving her?	Les.3 Ex.2
19.T	Come from the wire. What do you think? She is telling us that the charges are coming from the wire? What do you think? ()	
27.T	Who believes her?	
11.T	S ₄ , you've said you disagree with her, why?	Les.3, Ex.3
13.T	Do you agree or disagree with S ₁ ?	Les.4, Part 2

Here, the teacher is encouraging the pupils to think about the presented views and to criticise them by offering different or opposite opinions.

- At the final level, the teacher was inviting the whole class to evaluate the presented contradictory opinions by voting for the one they think is correct or to offer a new opinion if not convinced with those ones. By doing so, she was trying to identify

different ideas that the pupils held about the discussed issues. This indicates quite clearly the openness of the talk to the pupils' thoughts. The following utterances demonstrate this function of the initiation move:

7.T	Ok. Let's see how many of you agree with S ₁ ? 12. Ok. How many supports S ₂ ? 13. What about the rest of you?	Les.2, Part 1
13.T	What do you think girls?... Ok. S ₄ is insisting on her opinion	Les.2, Part 2
26.T	Who agrees with S ₆ ? Who agrees with S ₇ ?... So, all of you agree...	Les.2, Part 3
15.T	...How many of you support S ₅ ? () And the rest of you?	Les.3, Ex.2
11.T	...What do you think? How many of you agree with S ₃	Les.3, Ex.3

d) The response move: Many different ideas about the electric circuit were raised by the pupils in response to the teacher's initiations of the different levels mentioned above. The teacher asked for personal views, the pupils responded positively and the two were exchanging, therefore, Dialogic talk built over personal opinions. In fact, the pupils' contributions to this Dialogic talk differed in their length, and the levels of complexity, quality and certainty. These aspects link with each other, and it is difficult to distinguish one from another in describing the pupils' contribution. I try in what follows to exemplify these aspects with the excerpts of talk that seem to highlight a certain aspect of difference more than others do:

- **Length of the pupils' contributions:** In some cases, the pupils' contributions in expressing their opinions were short, and limited to providing only the possibility they think of without explaining the justification behind it. The excerpt below (Les.2, Part 1) shows such a shortly-expressed opinion (I-R_{1.1}-E_L-R_{1.2}-C₀):

1.T	..I wanna know, since I close the switch till the bulb lights, how long it takes? ...	I	
2.S ₁	Instantly	R _{1.1}	
3.T	You mean at the moment we close the circuit, the bulb lights? () S ₁ is saying instantly. Write her answer	F R _{1.2} , F	() S ₁ is nodding yes.

In other cases, however, the pupils' contributions extended in a long exchange of talk through which the pupils could explain their views in detail. Here is an excerpt (Les.4, Part 2) that goes on from turn 11 to turn 35 with only one pupil: I-R_{2.1}-I-R_{2.2}-E_L-R_{2.3}-E_L-R_{2.4}-E_L-R_{2.5}-E_L-R_{2.6}-E_L-R_{2.7}-E_L-R_{2.8}-E_L-R_{2.9}-R₃-E_L-R_{2.10}-E_L-R_{2.11}-E_L-R_{2.12}-C₀.

This exchange of talk is between a pupil, who seems to have some uncertain thoughts about the source of the charges that she wants to talk about, and a teacher, who wants to bring out these thoughts by questioning the pupil:

11.T	What do you think S ₂ ?	I
12.S ₂	Maybe the charges are basically moving on their own from the beginning	R _{2.1}
13.T	Do you agree or disagree with S ₁ ?	I
14.S ₂	A little (). Basically it has – the charges are moving there from the beginning	R _{2.2}
15.T	Where do they move?	F
16.S ₂	They move in the wire^ and go to the bulb	R _{2.3}

17.T	So when the circuit is opened, the charges are moving	F
18.S ₂	No, it's not they're moving. I mean it must - once the switch is off, the charges will meet together and complete the movement around. They move around, but. They move around - they don't move around in the wire ...	R _{2,4}
21.T	...They're there. If we take part of this wire and zoom it, and see the charges there as S ₁ has said. Now you're saying they're moving around, where?	F
22.S ₂	They move there, in their places	R _{2,6}
23.T	Their places ...	F
24.S ₂	No, they're there. It, it – the wire, and once we close it they'll continue their movement. Maybe they were - but when opened - once we close it the movement will keep on ...	R _{2,7}
33.T	...So directionally, they move in a directed way	F
34.S ₂	No - I don't know how. Maybe randomly... And after we close the circuit they will move around - before they don't move around	R _{2,12}

- The quality of the pupils' contributions:** In response to the teacher's high cognitive questions about the working of the electric circuit, the pupils provided answers that differed in their quality. They were expressing their personal thoughts. Some of these thoughts reflected low cognitive processes while others demonstrated high level thinking about the issue. Sometimes, the same pupil was showing both high and low cognitive processes while explaining the same point. Here is an excerpt (Les.4, Part 1) of a pupil's talk showing common misconceptions about the function of the battery. She is demonstrating a high level of thinking when she hypothesises the existence of the charges in the wire near the bulb. She argues that once the circuit is on, the charges instantly enter the bulb and light it:

1.T	...so there're negative charges that go in the bulb. Where do they come from?	I		
2.S ₁	Because of the movement. I mean because of the battery, that we put there, there will be a (...?) between the wire and the battery- from the wire they came	R _{1,1}	H	* H: CP of Analyse; break-down' (...?) inaudible - pause
3.T	So they'll come from the wire? They don't come from here? ()	F		() points to the battery
4.S ₁	I mean when they go there, the battery will give negative charges but will enter from there ()	R _{1,2}	L	() points to the part of the circuit near the bulb, but T seems not to hear it *L: misconception still persists
5.T	So still the battery will give charges	F		
6.S ₁	Negative. But that pole doesn't give, it will get from the bulb	R _{1,3}	L	-the positive pole in battery * L: usual thought in its context
7.T	Ok, this will get from the bulb. The battery will give negative charges () and these negative charges will go to? The bulb. In their way like this, moving, moving, moving, doesn't it take a time?	F		()S ₁ is nodding yeah
8.S ₁	No, no, cos when they move – when we switch on they'll enter from there()	R _{1,4}	H	() points again to the part of the circuit near the bulb * H: CP of 'Create; hypothesise'

- The complexity of the pupils' contributions:** The complexity of the pupils' presented opinions can be approached in different ways. It can be related to the length of their talk; as the more complex the opinion is the more exchanges of talk it takes. They can

also be related to the quality; as views that are more complex tend to show higher cognitive processes. However, there were incidents where some views were very clear and focused while others were vague and multifaceted without necessarily following the criteria of the relation of the complexity to the length or quality. Below is an excerpt (Les.3, Ex.2, Part.2) that shows two pupils, S₇ and S₈, offering their views about the source of charges. S₇ presented a high-cognitive view about the wire as the source of charges and justified it simply and clearly. S₈ offered a more complex view about two sources of charges; the battery and the wire. She goes on explaining her view by presenting a vague thought while describing how charges from both sources contribute to lighting the bulb:

21.T	...S ₇ , I heard you saying something and then you stopped, what do you think?	I	
22.S ₇	The wire has neutral charges ()	R _{7,1}	H
23.T	S ₇ is saying that the wire has charges...This means you're () raising a new opinion completely against what S ₅ has said. Is this right?	F	
24.S ₇	The wire is matter, and every matter has neutral charges	R _{7,2}	H
25.T	So, this wire has charges?	F	
26.S ₇	Yes	R _{7,3}	
27.T	Who believes her?	I	
28.S ₈	Yeah, right, cos the wire is matter and the battery also has charges	R _{8,1}	H
29.T	So, you're uttering an opinion different to what S ₆ & S ₇ have said. New opinion	F	
30.S ₈	Ok. And then. The wire and the battery have charges and so the all charges pass and reach the bulb and the bulb lights	R _{8,2}	L

- **The confidence of the pupils' with their contributions:** While presenting their opinions, the pupils differed in their confidence with their views. Some of them presented their views strongly while others expressed them hesitantly. Sometimes, the familiarity/unfamiliarity of the offered views played a role in specifying the level of pupils' confidence in speaking out their views. In the following two excerpts from the same example (Les.3, Ex.2, Part 1 & Part 2 respectively), two pupils express their views about the source of charges while describing how the electric current moves in the circuit and reaches the bulb. In the first one, the pupil looks very confident with her familiar view and expresses her thought very strongly:

9.T	...So these charges that are moving in the wire might finish one day	F	
10.S ₅	Yeah, they finish	R _{5,5}	
11.T	They finish. So, if I brought this wire, Could it end from charges in one day?	F	
12.S ₅	Miss. The wire doesn't have charges. It's a conductor for the movement	R _{5,6}	
13.T	It doesn't have charges. It's just a conductor for charges. So, where do the charges come from?	F	
14.S ₅	Aren't they coming from the battery !!	R _{5,7}	

Here, S₅ seems very convinced with her view regarding the movement of the charges in general and about the battery as a source of charges in particular. Her confidence appears more obviously in her firm response, in turn 12, that the wire does not have charges and in her wondering tone, in turn 14, that reflects her belief that the battery as

a source of charges is something unquestionable. In contrast, S₆ in the second excerpt is heard talking hesitantly about a view that is scientifically correct and reflects high cognitive thinking about the source and movement of charges:

14.S ₅	Aren't they coming from the battery !!	R _{5.7}
15.T	So this battery has charges that feed the wire (). And these charges might one day end up (). So, this is S ₅ 's opinion... You're disapproving her?	--- I
16.S ₆	Yes. The battery here gives kinetic energy for the charges to move and maybe the battery #	R _{6.2}
17.T	The battery gives the charges a kinetic energy that helps them to pass through. From where these charges are coming basically that it helps them to pass through?	F
18.S ₆	-- (Silence) From the wire	R _{6.3}
19.T	Come from the wire. What do you think? She is telling us that the charges are coming from the wire? What do you think? ()	F I
20.S ₆	I mean, what I know that the battery gives kinetic energy	R _{6.4}

Following S₅'s contribution in the previous excerpt, S₆, in this excerpt, presents thoughts of high cognitive level regarding the forms of energy and the source of charges. In spite of the brilliance of her contributions, she seems not as sure as S₅ was, and does not present her ideas as strongly as S₅ has done. Rather, her hesitation appears obviously in her silence in turn 16, and in her unsure way of expressing her view saying in turn 20: "I mean, what I know that...". Here, she tries to defend herself and attribute her view to an external source rather than her own thinking. However, this uncertainty can be understood in the light of the unfamiliarity of the views she was presenting as compared to the familiarity of views in the case of S₅.

e) The Follow-up move: Similar to her initiations, the teacher's follow-ups, whether commenting on or elaborating the pupils' responses, also played a major role in opening the talk to the pupils' ideas.

The Comment follow-ups: The neutral meanings embodied in the teacher's comments were giving the impression that all opinions were welcomed and accepted. Moreover, the teacher used the comments also to bring the attention of the class to the presented ideas (section 7.3.2.1). This has contributed in giving value to those opinions, and encouraged the pupils to speak out their thoughts. The teacher has done this through three main strategies:

- Highlighting a pupil's view and reviewing the main ideas it presents:

15.T	So, this is S ₅ 's opinion. The charges are in the battery basically, the wires allow these charges to pass. Pay attention. And then the charges when consumed up into heat, they finish. Ok?...	Les.3, Ex.2
15.T	Come from the battery, and of course the journey will be longer. This is S ₄ 's point of view...	Les.3, Ex.3

- Repeating a pupil's answer or reviewing it, and asking the class to write or remember it, and/or writing it herself on the board:

3.T	S ₁ is saying instantly. Write her answer. Instantly (B)	Les.2, Part.1
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59.T	Energy is made up of charges. Let's write your answer (B). And then the energy will move through the wires. The energy.... So we will keep these answers to the next lesson and will discuss...	Les.2, Part.4
11.T	S ₃ is saying that the current starts from here, passes... Let's write S ₃ 's answer. So, the path of the current as she said: (B) 1.Starts from the negative pole of the battery till it reaches ...	Les.3, Ex.1

- Reviewing all the offered views regarding a certain point and/or comparing them by showing their similarities or differences:

24.T	So you say, the energy comes from the wires inside the bulb. One of you said the battery and S ₇ is saying from the wires inside the bulb (B)	Les.2, part.3
35.T	Ok, thanks S ₂ ,... S ₂ is saying that the charges are moving randomly. Once we close... Ok? And S ₁ said that they are there basically, just near the bulb...	Les.4, Part.2
7.T	So, it starts from the battery. The start of this current is from the battery. We come back to the question that S ₉ has answered () and said that charges start their movement from the battery till they reach the bulb... This means you're supporting S ₉ ...	Les.3, Ex.1
29.T	So, you're uttering an opinion different from what S ₆ & S ₇ have said-new opinion	Les.3, Ex.2

The elaborative follow-up: Through the initiation move, the teacher was asking for the pupils' opinions, and through the comment move, she was valuing these opinions, but it was through the elaborative move that the teacher explored these opinions. The elaborative follow-ups of the teacher were not only stimulating the pupils to talk about their ideas, but were also examining those ideas in depth. This has contributed significantly to revealing the pupils' thoughts in detail. Indeed, the elaborative move played different functions in guiding the Dialogic talk. These functions will be explained in the next section. Nevertheless, whatever the function this move had been used for, it is its basic purpose of questioning the pupils' responses that proves the significance of this move in opening the talk to pupils' views.

7.3.2.3 The persistence of the elaborative voice of the teacher

The elaborative voice can be heard in both Authoritative and Dialogic classes of talk. Nevertheless, Dialogic talk, in the examples of this stage, illustrates a persistence of the elaborative voice of the teacher through continuous questioning of the pupil's responses. It is interesting that the quantitative representation of the Dialogic examples analysed by the framework manifest a dominance of the elaborative follow-up over the evaluative one that has disappeared completely (table 7.7).

I/D Excerpt	Follow-up		I/D Excerpt	Follow-up	
	E _v	E _L		E _v	E _L
Les.2 , Part 1	0	2	Les.3 , Ex.2, Part 2	0	4
Les.2 , Part 3	0	3	Les.3 , Ex.3	0	5
Les.2 , Part 4	0	13	Les.4 , Part 1	0	6
Les3. Ex.1	0	6	Les.4 , Part 2	0	10
Les3. Ex.2, Part 1	0	8	Les.4 , Part 3	0	...

Table 7.7: Comparison between E_v and E_L in I/D excerpts, C1, S2

The follow-up move has been characterised as elaborative for it is meant to extend the pupils' answers. Many elaborative moves that had been practised by the teacher in the examples of this stage had taken different forms of eliciting, diagnosing and prompting the pupils' responses. Nevertheless, looking into how these moves had been employed by the teacher brings to light two main divisions of functions that these follow-ups served and that contributed to specifying the purpose of talk. These are:

a) Exploring/Clarifying the pupils' ideas: To bring out the pupils' thoughts through the Dialogic talk, the teacher relied largely on her elaborative questions in addition to the ones posed through the initiation move. She kept on questioning pupils' answers, asking them to explain more about their ideas and encouraging them to criticise or evaluate each other's views. The following (Les.2, Part 4) is one of many excerpts that demonstrate the teacher's implementation of the elaborative follow-up to explore pupils' thoughts regarding the precise details of how the electric circuit works:

27.T	Ok, the next question, how did the energy come to the bulb?	I	
28.S ₈	Cos the electric charges move in the wire through the circuit	R _{8,1}	
29.T	The movement of charges through the wire (B).Still it's not clear, how #	F	E _L
30.S ₈	I mean it starts. It moves from the battery and through the wire	R _{8,2}	
31.T	So the charges are moving through the wire. How does this relate to the energy? I'm talking now about the energy. You said by the movement of the charges, how? Explain it to me	F	E _L
32.S ₈	Cos they are - when the switch is closed, the charges start to move - - till they reach the bulb	R _{8,3}	
33.T	The charges move. Kinetic energy - till they reach the bulb and it lights. So is the kinetic energy the reason for the lightness of the bulb?	F	E _L
34.S ₈	I mean the charges move	R _{8,4}	
35.T	They move but I just wanna know how the energy that you're talking about and saying it's from the battery, how did the charges move it to the bulb? You're saying, the charges are moving, Ok? I agree with you. But still you haven't link it to the energy. How did the energy reach the bulb?	F	E _L
36.S ₉	By the wire cos the wire is conductive for the energy. So the charges moved till they reached umm what's its name ...	R _{9,1}	
41.T	...Still you haven't explained how the energy got there? And then	...F	E _L
42.S ₉	I mean the charges (...?) in the wire, when we open the switch they #	R _{9,4}	
43.T	The charges are basically there in the wires? #	F	E _L
44.S ₉	Cos we're connecting them to the battery #	R _{9,5}	
45.T	So because they're connected to the battery, they're there in the wires, but before they're not there in the wires?	F	E _L
46.S ₉	I don't know	R _{9,6}	
47.T	It's ok, you're doing fine. Yes S ₁₀	F,I	C ₀
48.S ₁₀	The battery gives an electric energy and it passes through the wires #	R _{10,1}	

This excerpt is a part of a long episode of talk in which the teacher was trying to identify the pupils' views about how the energy reaches the bulb. The whole episode which ranges from turn 27 to 59 and involves three pupils, entails 13 elaborative follow-ups as compared to four comments without the evaluative move: I-R_{8,1}-E_L-R_{8,2}-E_L-R_{8,3}-E_L-R_{8,4}-E_L-R_{9,1}-C₀- I-R_{9,2}-E_L-R_{9,3}-C₀,E_L-R_{9,4}-E_L-R_{9,5}-E_L-R_{9,6}-C₀-I-R_{10,1}-E_L-I-R_{10,2}-E_L-R_{10,3}-E_L-R_{10,4}-E_L-R_{10,5}-E_L-R_{10,6}-C₀.

This pattern of discourse and the above exemplified part of this episode demonstrate how the teacher was using the elaborative move to get to the pupils' thoughts. The utterances below (separated from the aforementioned excerpt) indicate quite clearly the teacher's continuous and persistent demand from pupils to explain the relation between the movement of the charges and the carrying of energy to the bulb:

29.T	The movement of charges through the wire (B).Still it's not clear, how #	E _L
31.T	... You said by the movement of the charges, how? Explain it to me	E _L
33.T	...So is the kinetic energy the reason for the lightness of the bulb?	E _L
35.T	...I agree with you. But still you haven't link it to the energy. How did the energy reach the bulb?	E _L
41.T	...Still you haven't explained how the energy got there? And then	E _L
43.T	The charges are basically there in the wires? #	E _L
45.T	So because they're connected to the battery, they're there in the wires, but before they're not there in the wires?	E _L

b) Challenging/Negotiating the pupils' ideas: The second function, that the teacher used the elaborative move for, was to challenge the pupils' unfamiliar ideas. After identifying them, the teacher, in many examples, was negotiating these ideas with the pupils who presented them by trying to raise doubt about their possibility in front of the whole class. She was doing this through her persistent and detailed questions accompanied by a wondering doubting tone. Again, these questions were guided by the teacher's purpose and contributed, meanwhile, to specifying the purpose of talk in such examples to challenge pupils' ideas, which indicates a mutual influence of the two. The following excerpt (Les.3, Ex.3, Part 1) demonstrates the teacher's utilisation of the elaborative questions to challenge the pupils' ideas:

9.T	Ok, if I brought now instead of the short wires I've used, I use very loooong wires, Will the bulb light instantly? Or after a short period of time? Or after a long period? What do you think?	I	
10.S ₃	Instantly	R _{3,1}	
11.T	Instantly. So, if I used wires, their length, for example, equals the length of the class, Will it light instantly?...How many of you agree with S ₃ ? S ₄ , you've said you disagree with her, why?	F I	E _L
12.S ₄	Maybe because the charges need time till they arrive	R _{4,1}	
13.T	Maybe because the charges take time to reach the bulb. Because charges are coming from where to take time?	F	E _L
14.S ₄	Come from the battery	R _{4,2}	
15.T	Come from the battery, and of course the journey will be longer. This is S ₄ 's point of view. S ₃ , you're saying instantly, why? Don't they take time to move from the battery to the bulb?	F F	C ₀ E _L
16.S ₃	No	R _{3,2}	
17.T	Why, are they fast like the flash-lighting?	F	E _L
18.S ₃	Yes	R _{3,3}	
19.T	So, the bulb lights instantly because of their high speed? This is the reason?... S ₅	F...I	E _L
20.S ₅	... For example, if we notice the ones at home. When we turn them off, they go out immediately ()	...R ₅	
21.T	...So, you're saying this happens cos charges are fast... S ₅ is saying because of the speed of the charges, and S ₆ is saying because of the power of the battery, Ok?	F F	C ₀ C ₀
22.T	Let's hold this question to answer tomorrow, but think about it. Now, let's do the activity with the long wires. All of you, pay attention...		

This talk was exchanged after the pupils performed the first practical activity related to a simple electric circuit with short wires, and observed the instant glow of the bulb. Here, the teacher wanted to challenge the view of pupils regarding the instant lightness confirmed by the first activity by changing one variable; the length of the wires. Before conducting the activity under the new condition, she chose to take the pupils' prediction about it. She listened to four pupils; S₃, S₄, S₅ and S₆ (as turns 15 & 21 indicate) before closing the talk in turn 22 to perform the activity.

The excerpt above includes the whole exchange of talk between the teacher and two pupils: S₃ and S₄. By comparing the reaction of the teacher to both pupils' responses, it can be noticed that the teacher was trying to negotiate the unfamiliar views. In responding to S₄ who offered the expected view informing a short period of time, the teacher appears to support it. Through her reaction in turn 13 and 15, she was giving the message that this opinion is logical and understandable based on the perception of the battery as a source of charges, and she was, therefore, confirming this view instead of doubting it:

12.S ₄	Maybe because the charges need time till they arrive
13.T	Maybe...Because charges are coming from where to take time?
14.S ₄	Come from the battery
15.T	Come from the battery, and of course the journey will be longer...

Quite the opposite, the teacher is heard doubting S₃'s correct but unexpected view about the instant glow of the bulb. It seems that she wanted to challenge the offered view in order to encourage S₃ to speak out her thoughts with the hope that the correct scientific explanation would be offered by the pupils themselves. The teacher's challenging of the unfamiliar view appeared in several reactions of:

- After getting S₃'s answer of 'instantly' in turn 10, she repeats the question again in turn 11 and stresses the long length of the wires. By doing so, she was testing the pupil's persistence on her answer:

11.T	Instantly. So, if I used wires, their length, for example, equals the length of the class, Will it light instantly?...
------	--

- After taking a disapproving opinion from S₄, she comes back to S₃ in turn 15 and offers her the opposite view presenting the understandable justification. By doing so, she was challenging S₃ to provide a similar explanation to justify the instant lighting:

15.T	S ₃ , you're saying instantly, why? Don't they take time to move from the battery to the bulb?
------	---

- With the S₃'s insistence on her answer without providing an understandable explanation, she keeps the challenge by wondering about a mistaken expected explanation, with which S₃ agrees:

17.T	Why, are they fast like the flash-lighting?
18.S ₃	Yes

In response, she ends the exchange of talk with S₃ who failed to stand up to her

challenge by providing incorrect explanation for a correct prediction.

In another example (Les.3, Ex.2, Part.2), the teacher negotiates the view of pupils regarding the wire as a source of charges. This negotiation appears through her continuous questioning of the responses of the three pupils who supported this view entirely or partly. The teacher negotiates this unfamiliar idea not only through the elaborative follow-ups, but also with the help of the initiation and the comment follow-up moves, as the following utterances show:

17.T	The battery gives the charges a kinetic energy that helps them to pass through. From where these charges are coming basically that it helps them to pass through?	E _L
19.T	Come from the wire. What do you think? She is telling us that the charges are coming from the wire? What do you think?	C ₀ I
21.T	She knows that the battery gives kinetic energy. Ok, these charges are coming from where? S ₇ , I heard you saying something and then you stopped, what do you think?	C ₀ I
23.T	S ₇ is saying that the wire has charges, and that the battery gives the charges kinetic energy. This means you're raising a new opinion completely against to what S ₅ has said. Is this right?	E _L
25.T	So, this wire has charges?	E _L
27.T	Who believes her?	I
29.T	So, you're uttering an opinion different to what S ₆ & S ₇ have said. New opinion	C ₀

In these utterances, we hear the teacher challenging:

- S₆'s view of the battery as a source of energy by questioning the source of charges in turn 17, and stimulating the class in turn 21 to evaluate this view; 'She knows that..., what do you think?'
- S₇'s view of the wire as a source of charges by repeating her view in turn 25, attributing it to her explicitly (turn 23: S₇ is saying that...) and stimulating the rest of the class to evaluate it (turn 27: 'Who believes her?')
- S₈'s view of both the wire and the battery as sources of charges by comparing it to S₆ and S₇'s views (turn 29)

7.3.2.4 The share of control over the talk between the teacher and pupils

Classifying talk as Dialogic is based on the absence of the evaluative follow-up of the teacher and the openness of the talk to pupils' personal views. This openness *per se* illustrates the contribution of pupils in guiding the talk, which includes verbal and intellectual participation through the Interactive approaches and intellectual control through the Non-Interactive ones. The pupils' sharing of control was manifested through the following features of the talk:

a) 'Big' contributions of pupils (verbal and intellectual): It is quite easy to see pupils' role in keeping on the discussion in all Dialogic examples. However, in order to examine it here, it would be useful to spot the contribution of the pupils in one of the many Dialogic

excerpts and direct the attention to how the pupils were playing the 'big' role. Let us see the following excerpt (Les.3, Ex.1):

7.T	So...It starts from the battery till they reach the bulb?	F
8.S ₃	-- Yeah. Then the positive goes - then meet together - the bulb needs positive and negative charges	R _{3.2}
9.T	So this bulb needs positive and negative. Ok, come and show us this movement in the electric circuit	F I
10.S ₃	(Explains by talking and drawing that the negative charges will come out of the negative pole of the battery and pass through the wires, and positive charges starts from the positive pole and pass through the wires too, and when the two meet together in the bulb, it lights. She, however, mentions that positive charges do not cause the bulb to light up)	R _{3.3}
11.T	S ₃ is saying that the current... So, the path of the current as she said: (B) Starts... The positive charges start from the positive pole. Ok, how do they go to bulb?	F F
12.S ₃	They pass like this ()	R _{3.4}
13.T	So they also complete their round?	F
14.S ₃	Yes	R _{3.5}
15.T	Starts from the positive pole till they reach the bulb and completes its round (B) but don't they light up the bulb?	F F
16.S ₃	No	R _{3.6}
17.T	Don't they help in lighting the bulb	F
18.S ₃	No. unless the negative and positive meet in the bulb	R _{3.7}
19.T	So the bulb lights by the meeting of the charges...(B). Is there anyone has a disapproving opinion in describing the path of the current?	F I
20.S ₄	I don't disagree totally. I mean, I disagree with her when saying that it completes its round. It doesn't complete its round. It changes, I mean the lighting - still it has a kinetic energy. Then, it starts to lose its kinetic energy to light and heat, so the bulb lights because - I mean the energy has been lost because of the resistance	R _{4.1}
21.T	You've gone to the energy, you're saying that these charges... and when reaches the bulb it's to be transformed into what?...	F

In this example, S₃ and S₄ explain their views regarding the path of the current. The teacher carries on the talk about what S₃ thinks and believes, and maintains it then with S₄. In this regard, she continues to ask S₃ for more clarification by elaborating her answers: I-R_{3.1}-C₀,E_L-R_{3.2}-C₀-I-R_{3.3}-C₀,E_L-R_{3.4}-E_L-R_{3.5}-C₀-E_L-R_{3.6}-E_L-R_{3.7}-C₀. She also asks her to interpret a part of her idea about the movement of charges in a drawing that can show the route of charges (turn 9). In the mid of the talk, she reviewed S₃'s contribution by putting it into two points and writing them on board (turn 11) before continuing on elaborating her ideas through the following turns (11-19). It is not before she thought that she could bring out all thoughts of S₃ about the presented view, that the teacher shifted the talk to the class asking for another opinion in turn 19. In turn 20, S₄ starts to present a more complex view in which we can hear some brilliant thoughts about the energy within the whole system of the electric circuit's work. The talk continues to bring out S₄'s view (I-R_{4.1}-E_L...).

Both the teacher and pupils were participating to sustain this talk. Sometimes, the pupils were practising more verbal control (see turns 10 & 20) while in other times, it was the teacher who was controlling it (see turns, 11 & 19). Although the teacher had the power in directing the questions, yet it was the pupils' thoughts that constituted the answers to these

questions without any reference to 'a correct scientific one'. This means that the pupils in such a Dialogic talk were a source of knowledge that the teacher was receiving and making sure she 'gets it all'. The talk was not moving towards the scientific account- which necessitates an intellectual control on the part of the teacher- but towards the personal views of the pupils, which gave them a big share of the intellectual control over the talk.

Such a shift in roles and shares of control had resulted in long episodes of Dialogic talk and a big contribution of each pupil as the patterns of discourse of the different Dialogic examples demonstrate, some of which are:

Pattern of discourse	Example
I-R _{8,1} -E _L -R _{8,2} -E _L -R _{8,3} -E _L -R _{8,4} -E _L -R _{9,1} -C ₀ - I-R _{9,2} -E _L -R _{9,3} -C ₀ ,E _L -R _{9,4} -E _L -R _{9,5} -E _L -R _{9,6} -C ₀ -I-R _{10,1} -E _L -I-R _{10,2} -E _L -R _{10,3} -E _L -R _{10,4} -E _L -R _{10,5} -E _L -R _{10,6} -C ₀	Les.2, Part 4
I-R _{5,1} -E _L -R _{5,2} -E _L -R _{5,3} - E _L -R _{5,4} -E _L -R _{5,5} -E _L -R _{5,6} -E _L -R _{5,7} -E _L -R _{5,8} -E _L -R _{5,9} -C ₀	Les.3, Ex.2, Part 1
I-R _{2,1} -I-R _{2,2} -E _L -R _{2,3} -E _L -R _{2,4} -E _L -R _{2,5} -E _L -R _{2,6} -E _L -R _{2,7} -E _L -R _{2,8} -E _L -R _{2,9} -R ₃ -E _L -R _{2,10} -E _L -R _{2,11} -E _L -R _{2,12} -C ₀	Les.4, Part 2

Table 7.8: Examples of the patterns of discourse of I/D excerpts, C1, S2

b) Informality of the talk: Opening a discussion about a certain issue with someone and listening to his/her personal opinion about that issue gives the talk an informal quality, and this is what was happening in the Dialogic classes of talk. As we can just sense the informality of the talk in some examples, we can see some definite indicators of this informality in others.

One such indicator is the interruption of the teacher and the pupils to each other. In the excerpt (Les.3, Ex.2, Part.1) below, for example, the teacher's interruption of S₅ and the opposite, can be heard clearly in the video recording of the talk:

2.S ₅	It doesn't work. I mean, it will transform from light to heat. It will end up	R _{5,1}	
3.T	You mean these electrons, I mean these charges, will change to?	F	
4.S ₅	Light #	R _{5,2}	# T interrupts S ₅
5.T	Light before, and after the light #	F	# S ₅ interrupts T
6.S ₅	Heat	R _{5,3}	
7.T	It transforms into heat and then spills out #	F	# S ₅ interrupts T
8.S ₅	Yeah, spill out as heat till the energy of the battery ends up	R _{5,4}	

We find here that the teacher directed the questions, S₅ expressed her thoughts quickly and strongly, and the teacher responded to the presented thoughts neutrally; both were following each other's reaction promptly. This interruption and prompt neutral successive responses, from each of them, reflect a more neutral relation of power, where the two poles (the teacher and S₅ in this case) share the verbal and the intellectual control over the talk without either of them dominating.

The informality of the talk also appeared sometimes in the substitution of explicit wording with demonstrative pronouns, adverbs and gestures. In the following excerpt (Les.4, Part 1), for example, we hear the words 'here, there, that, these' supported by some gestures from

both the teacher and S₁. Meanwhile, we do not hear any of them asking the other what is meant by these pronouns or adverbs. Instead, the exchange of the talk continues easily and smoothly. This easiness in the communication between the two resulted eventually in characterising multiple kinds of moves in one turn (turn 11). In this turn, the teacher is heard questioning S₁'s answers and S₁ is seen using her body language to respond to these questions:

3.T	So they'll come from the wire? They don't come from here? ()	F	() T points to the battery
4.S ₁	I mean when they go there, the battery will give negative charges but will enter from there ()	R _{1.2}	() S ₁ points to the part of the circuit near the bulb, but T seems not to hear it
5.T	So still the battery will give charges	F	
6.S ₁	Negative. But that pole doesn't give, it will get from the bulb	R _{1.3}	-the positive pole in battery
7.T	Ok, this will get from the bulb. The battery will give negative charges () and these negative charges will go to? The bulb. In their way like this, moving, moving, moving, don't they take a time?	F	() S ₁ is nodding yeah
8.S ₁	No, no, cos when they move – when we switch on they'll enter from there ()	R _{1.4}	() S ₁ points again to the part of the circuit near the bulb
9.T	So when these moves these will move? ()	F	() T points to: 1 st these, charges near the battery, 2 nd these, charges near the bulb
10.S ₁	Yeah	R _{1.5}	
11.T	At the same time? () These and these will move together? () So you do explain by this the Instant lightning? ()	F, R _{1.6} F, R _{1.7} I, R _{1.8}	() S ₁ is nodding yeah () S ₁ is nodding yeah () S ₁ is nodding yeah

7.3.3 What has influenced the level of the Dialogic talk?

This section begins with differentiating between the levels of the Dialogic examples of this stage, followed by explaining the factors that led to and/or influenced the talk to take one of these levels.

7.3.3.1 Levels of Dialogic talk

The Dialogic examples of the talk in this stage appeared to reflect different levels as the dialogic features look less evident in some examples than others. The main attribute that divides Dialogic talk into these levels is the purpose and flow of the talk.

Level 1: Exploring the pupils' ideas superficially

In the excerpts following this purpose, the talk is characterised with a follow-up dominated by comments with no or few elaborative moves as the teacher does not go deeply into questioning the presented ideas. The initiation move continues, but usually asking only for another opinion. Therefore, more pupils participate in the talk but their contributions are limited to short and superficial views usually. The features of the substitution of the evaluative stance with a neutral one and the openness of the talk to the pupils' superficial ideas

characterise obviously the Dialogic talk in this level. However, the elaborative voice disappears and the pupils seem to share a little control over the talk. Here are two short examples explaining this level:

- Excerpt 1 (Les.2, part.2): I-R₃-C₀- I-R₄-C₀

9.T	What forms of energy are given out by the electric bulb?	I	
10.S ₃	Light	R ₃	
11.T	Light (B), other opinion?	F, I	C ₀
12.S ₄	Light and heat	R ₄	
13.T	Light and heat (B)	F	C ₀

- Excerpt 2 (Les.2, Part.1): I-R_{1.1}-E_L-R_{1.2}-C₀-I-R_{2.1}-E_L-R_{2.2}-C₀

1.T	... I wanna know, since I close the switch till the bulb lights, how long it takes?...	I	
2.S ₁	Instantly	R _{1.1}	
3.T	You mean at the moment we close the circuit, the bulb lights? (S ₁ is nodding yes) S ₁ is saying instantly. Write her answer. Instantly (B). Anyone has another opinion? S ₂	F R _{1.2} F I	E _L C ₀
4.S ₂	Short	R _{2.1}	
5.T	Short. You mean after a short period of time the bulb will light (S ₁ is nodding yes) Ok.	F R _{2.2} ,F	E _L C ₀

Level 2: Exploring the pupils' ideas in detail

The follow-up in the second dialogic level is quite the opposite to the first one; dominated by elaborative moves with few comments that come usually at the end of the talk regarding a certain issue. As the teacher in this level tends continuously to elaborate the pupils' responses, this talk witnesses the absence of new questions through the initiation moves apart from the first and the main one. The teacher is more likely to consider the pupils as the sources of knowledge. Therefore, her neutral stance in listening to many personal views without evaluating them appears strongly in this level. Hence, the talk in this level is featured with its openness to the pupils' profound thoughts, which gives more verbal and intellectual control to the pupils. Consequently, the excerpts of this level are more likely to be long with more contributions from each pupil, as the following example shows:

- Excerpt 1 (Les.3, Ex.2, Part.1): I-R_{5.1}-E_L-R_{5.2}-E_L-R_{5.3}- E_L -R_{5.4}-E_L-R_{5.5}-E_L-R_{5.6}-E_L-R_{5.7}-E_L-R_{5.8}-E_L-R_{5.9}-C₀.

1.T	...Does anyone have another opinion? Let's hear S ₅	I	
2.S ₅	It doesn't work. I mean, it will transform from light to heat. It will end up	R _{5.1}	
3.T	You mean these electrons, I mean these charges, will change to?	F	E _L
4.S ₅	Light ...	R _{5.2}	
9.T	...So these charges that are moving in the wire might finish one day	F	E _L
10.S ₅	Yeah, they finish	R _{5.5}	
11.T	They finish. So, if I brought this wire, Could it ends from charges in one day?	F	E _L
12.S ₅	Miss. The wire doesn't have charges. It's a conductor for the movement	R _{5.6}	
13.T	It doesn't have charges...So, where do the charges come from?	F	E _L
14.S ₅	Aren't they coming from the battery !!	R _{5.7}	
15.T	So this battery has charges that feed the wire... So, this is S ₅ 's opinion. The charges are...	F ... F	E _L C ₀

Level 3: Challenging and negotiating the pupils' ideas

The features of this level of Dialogic talk do not look as distinctive as the ones characterising the first two levels. The excerpts in this level do not point to a dominance of any of the follow-up kinds over the other, as the comment and elaborative moves continue throughout the talk. Related to this characterisation is the progression of the initiation move in this dialogic level as the teacher asks more questions regarding similar or different points. The elaborative voice of the teacher persists, not through the elaborative follow-up only, but also through employing the initiation and the comment and elaborative moves together. Certainly, the talk here is opened to the pupils' deep thoughts but the teacher challenges these thoughts. Therefore, the pupils do not take a bigger share of control, nor does the teacher. Instead there is a more balanced relation in controlling the talk in this level. Below is an example of this level:

- Excerpt 1 (Les.3, Ex.2, Part.2): I-R_{6.1}-I-R_{6.2}-C₀,E_L-R_{6.3}-C₀-I-R_{6.4}-C₀-I-R_{7.1}-E_L-R_{7.2}-E_L-R_{7.3}-I-R_{8.1}-C₀-R_{8.2}-E_L-R_{8.3}-C₀.

15.T	You're disagreeing with her?	I	
16.S ₆	Yes. The battery here gives kinetic energy for the charges to move...	R _{6.2}	
17.T	The battery gives...From where these charges are coming basically...?	F	E _L
18.S ₆	-- From the wire	R _{6.3}	
19.T	Come from the wire. What do you think?...	F, I	C ₀
20.S ₆	I mean, what I know that the battery gives kinetic energy	R _{6.4}	
21.T	She knows that... S ₇ I heard you saying...what do you think?	F, I	C ₀
22.S ₇	The wire has neutral charges...	R _{7.1}	
25.T	..So, this wire has charges?	F	E _L
26.S ₇	Yes	R _{7.3}	
27.T	Who believes her?	I	
28.S ₈	Yeah, right, cos the wire is a matter and the battery also has charges	R _{8.1}	
29.T	So, you're uttering an opinion different to what S ₆ & S ₇ have said. New opinion	F	C ₀
30.S ₈	Ok. And then. The wire and the battery have charges and so the all charges pass and reach the bulb and the bulb lights	R _{8.2}	
31.T	All the charges, positive and negative pass?	F	E _L
32.S ₈	Yes	R _{8.3}	
33.T	All the positive and negative charges pass...	F	C ₀

Figure 7.2 sums up the previous characterisation of the three dialogic levels and explains the similarities/differences between them.

Levels of Dialogic talk	Lowest level ----- Highest level		
	Low-Dialogic talk-----	Mid-Dialogic talk -----	High-Dialogic talk
	Exploring pupils' ideas superficially	Exploring pupils' ideas in detail	Challenging pupils' ideas
Frequency of follow-ups	Dominated by comments	Dominated by elaboration	Comments and elaboration persist
Pattern of discourse	The (I-R-C ₀) and the (I-R-E _L -R-C ₀) sequences persist	The (I-R-E _L -R-E _L ...C ₀) sequence persists	The (I-R-C ₀ ,E _L -R-C ₀ ,E _L ...C ₀) sequence persists
Pupils' contribution	More pupils are presenting superficial ideas	Fewer pupils are detailing their ideas	Fewer or more pupils are detailing and defending ideas
Features of the talk	-Neutral stance of the teacher	-Neutral stance of the teacher	-Neutral stance of the teacher
	-Openness to the pupils' superficial ideas	-Openness to the pupils' profound ideas	-Openness to the pupils' profound ideas
	-No persistence of the elaborative voice	-Persistence of the elaborative voice mainly through the elaboration follow-up	-Persistence of the elaborative voice through the initiation and the follow-up moves
	-Pupils share less control in presenting superficial ideas	-Pupils share more control by presenting profound ideas	-Pupils share more control by presenting profound ideas

Figure 7.2: Levels of Dialogic talk

7.3.3.2 What has influenced the dialogic levels?

Putting the Dialogic talk into the three levels, based on the purpose of the talk and the teacher's intervention, points again to the teacher's fundamental influence in specifying these levels. She was trying in this stage to practise more Dialogic talk, and when she succeeded in doing so, it was mostly because of her own attitude and intervention. Nevertheless, the pupils' influence can still be discussed as the pupils were participating in pushing the Dialogic talk in each level forward. The contextual factors appear to have also influenced the teacher's intervention in starting and guiding this talk.

1. Pupils' influence

The pupils' influence in pushing the Dialogic talk forward can be spotted more clearly in the last two levels in which their views have been explored in detail and challenged. In many examples, the teacher did not need to ask for another opinion and wait for pupils to respond to her and start talk about their views. Instead, we can see the pupils paying attention to each other's answer and showing their willingness to participate in the discussion before the teacher asks for another opinion. The excerpt below (Les.2, Part.4) demonstrates such feature of the pupils' contribution:

27.T	Ok, the next question, how did the energy come to the bulb?	I	
28.S ₈	Cos the electric charges move in the wire through the	R _{8,1}	

	circuit...		
35.T	...But still you haven't link it to the energy. How did the energy reach the bulb? ()	F	() S ₈ does not respond and S ₉ raises her hand
36.S ₉	By the wire cos the wire is conductive for the energy. So...	R _{9,1}	
45.T	...So because they're connected to the battery, they're there in the wires, but before they're not there in the wires?	F	
46.S ₉	I don't know ()	R _{9,6}	() S ₉ looks confused
47.T	It's ok, you're doing fine. Yes S ₁₀	F, I	() S ₁₀ raises her hand
48.S ₁₀	The battery gives an electric energy and it passes through the wires...	R _{10,1}	

These utterances are part of a long episode of talk (turns 27-59) about the question in turn 27. Through the turns 28-34, S₈ was trying to explain her opinion, and the teacher was listening to her answers without evaluating them. The teacher kept asking for more clarification, therefore, she and the whole class can understand S₈'s precise view of how the energy reaches the bulb. In turn 35, the teacher was still directing the talk to S₈ who looked confused and did not respond. This is when S₉ raised her hand to offer an answer to the question that S₈ did not respond to. The same scenario repeated itself with S₉ and S₁₀. Again, the teacher was trying to explore S₉'s thoughts deeply, S₉ got confused and admitted that she does not know (turn 46), and S₁₀, even without being asked, expressed her willingness to join the discussion and talk about her view.

Hence, although this stage did not witness talk initiated by pupils, yet their role in guiding the talk and keeping it going appeared in the form of their readiness to offer their opinions and express their agreement or disagreement with the presented views without being always asked directly to do so. This means that pupils did not only support the dialogic orientation of the teacher, but also practised themselves the dialogic manner while listening to each others' opinions, thinking about them and enriching the talk with more ideas on the discussed issues.

Moreover, in disapproving some of the conventional views and presenting unusual ones, the pupils were contributing to specify the dialogic talk to be of the high level of challenging these unusual views. For example, in the excerpt (les.3, Ex.2, Part.2) that I went through previously (see p.168, 175), one pupil's views of the battery as a source of energy and the wire as a source of charges motivated the teacher to initiate a talk in which she tried to negotiate these unexpected views with the pupil who presented them in particular, and with the whole class in general.

2. Contextual factors

The three levels of the Dialogic talk have been related to the contextual factors regarding the purpose of the talk, the content of the subject matter and the teaching intervention. To start a general discussion about some of the basics of the electric circuit, the teacher initiated

a Dialogic talk of the first level to identify the pupils' superficial ideas about the issues under discussion:

1.T	...I wanna know, since I close the switch till the bulb lights, how long it takes? Does it take a short period of time or a long one? Or will it lights instantly?	Les.2, Part.1
9.T	What forms of energy are given out by the electric bulb?	Les.2, Part.2
14.T	Now, what's the source of this energy?	Les.2, Part.3

She practised more of a neutral voice than elaborative one in listening to the pupils' opinions on these points. She did not ask for justifications or detailed explanations for the presented views. After identifying the overall personal views, she moved the talk to its second dialogic level of exploring in detail the pupils' thoughts behind these views. The content of the scientific subject matter necessitated the Dialogic talk to go deep in order to dig up what the pupils think about regarding the working of the electric circuit in relation to the two conceptions of charges and energy as well as the relation between them:

27.T	Ok, the next question, how did the energy come to the bulb?	Les.2, Part.4
5.T	I want to describe how the electric current moves in the circuit... Describe it, where does it start from? What does it pass through? And Is it definitely that this current moves through the all parts of the circuit or just through certain parts of the circuit?	Les.3, Ex.1,

Following these two main initiations, the teacher asked many questions through the initiation and elaborative moves. She asked the pupils to explain, analyse, hypothesise, and justify the discussed issues. Furthermore, she challenged their unusual ideas to stimulate argument on different ideas. In doing this, she implemented the empirical content as a part of her intervention. For instance, some pupils offered the view of instant lighting regarding the time that the bulb needs to glow. This view was approved by the practical activity of working with a normal electric circuit. However, the teacher asked for the pupils' prediction of the time of lightness if very long wires connected the circuit, in order to stimulate more debate on this point. Then, she used the result of this activity to motivate the pupils to think deeply about what may be a correct scientific explanation for such empirical observation. This, in turn, had developed the dialogic level of the talk as the pupils were contributing effectively to push it forward and enrich it with thorough and brilliant ideas:

7.T	Ok, this will get from the bulb. The battery will give negative charges () and these negative charges will go to? The bulb. In their way like this, moving, moving, moving, doesn't it take a time?	Les.4 , Part.1
8.S ₁	No, no, cos when they move – when we switch on they'll enter from there (S ₁ points to the part of the circuit near the bulb)	
9.T	So when these (Charges near the battery) move these (Charges near the bulb) will move?	
10.S ₁	Yeah...	

13.T	Do you agree or disagree with S ₁ ?	
14.S ₂	A little (). Basically it has – the charges are moving there from the beginning	
15.T	Where do they move?	

16.S ₂	They move in the wire^ and go to the bulb...	Les.4 , Part.2
21.T	...They're there. If we take part of this wire and zoom it, and saw the charges there as S ₁ has said. Now you're saying they're moving around, where?	
22.S ₂	They move there, in their places...	

Hence, this suggests that the content of both difficult and complicated subject matter and that of empirical nature has been used not only to explore the pupils' views in detail but also to challenge them. This has influenced the Dialogic talk to be of a higher level consequently.

7.3.4 How does the Dialogic talk seem to support/not support pupils' learning?

The teaching in this stage was a practice of both Dialogic and Authoritative talk. While commenting on the pupils' conceptual understanding by using the focus group data in the next section, the findings will be attributed to the whole CT practice, Authoritative and Dialogic. In this section, however, the focus is directed towards the Dialogic talk only, to look into the indicators of the pupils' engagement, quality of questions and responses, and pupils' developing understanding.

7.3.4.1 Pupils' engagement

Most of the examined Dialogic examples refer quite clearly to the pupils' engagement in the discussion about the raised issues. Most specifically, the accounts of the openness of the talk to the pupils' views through the response move (section 7.3.2.2) and the pupils' share of control over the talk (section 7.3.2.4) prove that the pupils were engaged in the ongoing talk, and describe how they were enriching the talk with their ideas. Pupils' engagement in the ongoing CT is a positive indicator of learning. Nevertheless, I highlight in this section the advantages the pupils may gain because of their engagement, and which are expected to have supported their learning and motivation to learn. Prior to this, I focus on the same indicators discussed for Authoritative talk (section 6.3.3.1) to show how similar practice can be found in the Dialogic, however, with a different context that grants it different meaning and different influence on pupils' learning consequently.

In the Dialogic episodes, there were some incidents of group answers similar to what has been noticed in the Authoritative talk in the first stage. However, all of those incidents share the same context; the groups of pupils were voting for the opinion they support among the several presented ones. Through these group answers, the pupils were not responding to questions of conceptual knowledge for which the answers were already known as it happened in the Authoritative talk. Here is one example (Les.2, part.1) of group answers in the Dialogic talk:

5.T	...So no one is saying after a long period?	I
6.S _g	No	R _g
7.T	Ok. Let's see how many of you agree with S ₁ ? 12. Ok. How many supports S ₂ ? 13. What about the rest of you?	F I, R _g , F I, R _g , F I
8.S _g	Not taking any side	R _g

Regarding the feature of the teacher's neglect of the pupils' ideas that was noticed through the practice of Authoritative talk in the first stage, there were some incidents of Dialogic talk as well where the teacher refused to listen to more personal views of pupil about a certain issue. However, the situation was different from what happened in the Authoritative talk, in which the teacher was neglecting the pupils' thoughts in general and discounting their views when uttered in particular. In the Dialogic examples of this stage, the teacher was declaring in some incidents that she would not take any other views. This was part of her management of the lesson time and the shift among the different classes of talk. In these incidents, moreover, the teacher had already listened to different views that reflect frequently usual and unusual ideas. Here are two examples demonstrating this occurrence where the teacher announces directly and indirectly that she will not listen to more views:

21.T	...So, you're saying this happens cos charges are fast... S ₅ is saying because of the speed of the charges, and S ₆ is saying because of the power of the battery, Ok?	Les.3 Ex.3
22.T	Let's hold this question to answer it tomorrow, but think about it. Now, let's do the activity with the long wires. All of you, pay attention...	
37.T	Ok, this is enough, enough. Let's try to explain now one thing, why do the bulb lights instantly, but before, we need to see the situation of the charges before the circuit is closed, and their situation after the circuit is closed? Ok? Let's see this flash...	Les.4 Part.3

Being in the environment of Dialogic talk -where every opinion is welcomed, and opposite opinions are questioned and negotiated without being evaluated- is an advantage for the pupil as it enhances their learning. In what follows, I highlight the features of the Dialogic talk that seem to support the pupils' engagement in argumentation and dialogic discussions, and also show how this engagement can be seen as an advantage in itself:

- What was remarkable about the teacher in practising her role in the Dialogic talk is how she was giving the chance to pupils to think and re-think aloud. In her elaboration of their answers, she was trying to make them deconstruct their thoughts, analyse and organise them in order to develop their views towards a more logical account that would eventually lead to the scientific one. This means that the teacher was not using the Dialogic talk only to explore the pupils' ideas but also to motivate the pupils indirectly to explore their ideas themselves and check their logic and consistency with scientific facts, as most of the Dialogic examples that have been used through this chapter prove. The following short excerpt (Les.2, Part.3) exemplifies this feature:

30.S ₈	I mean it starts. It moves from the battery and through the wire	R _{8,2}
31.T	So the charges are moving...How does this relate to the energy? I'm talking now about the energy... Explain it to me	F
32.S ₈	Cos they are - when the switch is closed, the charges start to move - - till they reach the bulb	R _{8,3}
33.T	...So is the kinetic energy the reason for the lightness of the bulb?	F
34.S ₈	I mean the charges move	R _{8,4}
35.T	They move but I just wanna know how the energy that you're talking about and saying it's from the battery, how did the charges move it to the bulb?...	F
36.S ₉	By the wire cos the wire is conductive for the energy. So the charges move...	R _{9,1}

- In few incidents, the pupils were given the chance through the Dialogic talk to predict, assume and/or vote for the arguments before they could be tested by experiment. This gave them a chance to practise the scientific mode of inquiry:

33.T	...That's enough for now. We've heard different opinions. Some are saying that the battery is the source of the charges and passes these charges to the wires... This is basically the opinion of S ₅ , but S ₇ said No. the wire... Ok let's try and see and let's memorise our answers. We're gonna do an activity now. From this activity, I wanna you to focus on the first two questions and investigate their answers...now we'll design an electric circuit...	Les.3, Ex.2, Part 2
34.T		

- Sometimes, the pupils were insisting on their opinions although most of the class seemed not to agree with them (excerpt 1: Les.2, Part 2), and even the teacher had shown obvious doubting (excerpt 2: les. 3, Ex.2, part 2):

9.T	... What forms of energy are given out by the electric bulb? (Les.2, part.2)	I
10.S ₃	Light	R ₃
11.T	Light (B), other opinion?	F, I
12.S ₄	Light and heat	R ₄
13.T	Light and heat (B). What do you think girls?... Ok. S ₃ is insisting on her opinion	F, I, R _g , F

22.S ₇	The wire has neutral charges ()	R _{7,1}
23.T	S ₇ is saying that the wire has charges, and that the battery gives the charges kinetic energy. This means you're () raising a new opinion completely against to what S ₅ has said. Is this right?	F
24.S ₇	The wire is a matter, and every matter has neutral charges	R _{7,2}
25.T	So, this wire has charges?	F
26.S ₇	Yes	R _{7,3}

Such a practice in which the pupils were given the right to speak, defend and persist with their opinions, in itself, reflects a positive indicator of a supportive learning environment. In disregard to the correctness of the opinions, it is good for the pupils to practise their right in expressing themselves and insisting on what they believe. At the end, the pupils have to follow what is considered scientific. Through the Dialogic talk, however, the pupils can practise their right to speak their thoughts without being refused or denied, to defend these thoughts, and to change them when they are convinced with their incorrectness. They can then follow the scientific view or may keep their own thoughts if they are not still convinced. It is a skill *per se* for a pupil to find a balance between his/her and other's view, and to implement both of them, each in its context.

Moreover, the discussed examples were not showing a teacher trying to transfer knowledge to pupils, but the one who negotiates the pupils' personal views of scientific issues. Such a practice may be seen as a training for the pupils to learn how to negotiate ideas, analyse what is said, follow the inconsistency or the logic of others' views and evaluate them. It can also influence the pupils to analyse their views and put their thoughts together to support them. Consequently, the pupils were heard expressing their agreement or disagreement very smoothly and confidently sometimes. Many of the examples displayed through this chapter demonstrate this feature, one of which is the following (Les.3, Ex.1):

15.T	Starts from the positive pole till they reach the bulb and completes its round (B) but don't light up the bulb?	F F
16.S ₃	No	R _{3.6}
17.T	Don't they help in lighting the bulb	F
18.S ₃	No. unless the negative and positive meet in the bulb	R _{3.7}
19.T	So the bulb lights by the meeting of the charges in the bulb (B). Is there anyone has a disapproving opinion in describing the path of the current?	F I
20.S ₄	I don't disagree totally. I mean, I disagree with her when saying that it completes its round. ...It changes, I mean the lighting - still it has a kinetic energy. Then, it starts to lose its kinetic energy to light and heat...	R _{4.1}

This means that the Dialogic talk practised in this case- ranging in its levels from the simplest to the highest- proves to be a significant attribute to engaging the pupils in their learning through their contribution to the teaching process.

7.3.4.2 Quality of questions and responses

The results on the cognitive level demonstrate that the Dialogic talk has invited questions of high quality. This, in turn, has influenced the pupils to offer responses of high quality every so often. In this regard, the quantitative representation of the quality demonstrates that questions of high cognitive level have dominated the Dialogic talk (table 7.9). The teacher was asking for the pupils' thoughts and, therefore, the initiated questions were open to invite pupils to offer different views. The elaborative questions were also of high quality as the teacher was asking the pupils to practise high cognitive processes while analysing and explaining the presented views in more detail. Consequently, many of the pupils' answers came to reflect such high cognitive processes, which resulted, therefore, in many responses of high quality (table 7.10):

Examples of Dialogic talk	Quality of questions		Examples of Dialogic talk	Quality of questions	
	Low	High		Low	High
Les.2, Dialg.1	0	3	Les.3, Dialg.3	0	5
Les.2, Dialg.2	0	2	Les.3, Dialg.4	2	3
Les.2, Dialg.3	1	4	Les.4, Dialg.1	1	4
Les.2, Dialg.4	0	15	Les.4, Dialg.2	0	10
Les.3, Dialg.1	1	4	Les.4, Dialg.3	0...	1...
Les.3, Dialg.2	2	4			

Table 7.9: Quality of Questions in I/D excerpts of C1, S2

Examples of Dialogic talk	Quality of responses		Examples of Dialogic talk	Quality of responses	
	Low	High		Low	High
Les.2, Dialg.1	1	1	Les.3, Dialg.3	1	6
Les.2, Dialg.2	1	1	Les.3, Dialg.4	5	1
Les.2, Dialg.3	3	2	Les.4, Dialg.1	2	3
Les.2, Dialg.4	6	8	Les.4, Dialg.2	2	10
Les.3, Dialg.1	6	1	Les.4, Dialg.3	0...	1...
Les.3, Dialg.2	3	3			

Table 7.10: *Quality of Responses in I/D excerpts of C1, S2*

It may also be noticed, however, that although most of the teacher's questions were of high quality, the pupils' responses did not reflect the same frequency of this level. This means that the results do not show a constant cognitive correspondence between the level of the teacher's questions and the level of the pupils' responses. However, this is not because the teacher was asking for certain high-level answers, and was not getting them. Rather, the teacher was asking the pupils to express and explain their views and the pupils were doing so, but their views were not necessarily reflecting high cognitive processes. They were a mixture of usual and unusual, correct and incorrect views including scientific conceptions and misconceptions, and reflecting both low and high cognitive processes in thinking about the discussed issues. This means that high questions in Dialogic talk are not necessarily expected to invite responses of high quality. Meanwhile, this does not mean that the pupils' contributions of low cognitive level are not valuable. They are valuable because they disclose pupils' ideas. They still hold to some kind of thinking about the issues under discussion even if they do not seem to reflect high cognitive processes. They are also valuable because they reveal important misconceptions. The exposure/disclosure of pupils' misconceptions is an advantage in itself, as it will be explained in the next sub-section.

7.3.4.3 Pupils' developing understanding

In the first case, the Authoritative talk could not be followed for the indicators of pupils' developing understanding due to the absence of 'big' contributions from the pupils. Looking into CT for evidence on this aspect is a tricky thing, and is highly dependent on the available data. One way to do this is to trace general indicators that are observed continuously and clearly. The other way is to follow the storyline of one of the pupils, if the data allows, and analyse her understanding chronologically through successive lessons. There is an attempt made here to follow both routes.

Overall, the amount of pupils' ideas and thoughts, that the examples of the Dialogic talk contain, indicate richness of the conceptual knowledge available for all the participants to think about. It is true that this knowledge is a mixture of mistaken and correct views, but any of the two might reflect certain justifications that would be crucial to progressing with conceptual acquisition. If the teaching is planned to disclose the misconceptions of the

pupils as a first step in developing the scientific view, then the Dialogic talk as practiced by this teacher, in this stage, is a fundamental means to do this. Here, I follow the contribution of the Dialogic talk in revealing the misconceptions and influencing the pupils to develop their mistaken ideas towards more scientific ones.

- By exploring the pupils' ideas and guiding the talk in the way that gave the pupils a chance to share those ideas with each other as with her, the teacher allowed different misconceptions regarding the electric circuit to be exposed, some of which are:

1.T	...since I close the switch till the bulb lights, how long it takes? Does it take a short period of time...? Or will it lights instantly?...	Les.2, Part 1
4.S ₂	...Short	
37.T	...From where did the charges move?	Les.2, Part 4
38.S ₉	From the battery of course	

- Even when the pupils were offering correct views, further elaboration of these views pointed sometimes to mistaken justifications:

43.T	The charges are basically there in the wires?	Les.2, Part.4
44.S ₉	Cos we're connecting them to the battery	
15.T	...S ₃ , you're saying instantly, why? Don't they take time to move from the battery to the bulb?	Les.3, Ex.3
16.S ₃	No	
17.T	Why, Are they fast like the flash-lighting?	
18.S ₃	Yes	

- Sometimes, it was the opposite; what looks like incorrect answers were actually based on sophisticated thinking. Dialogic talk allowed the different thoughts to be spoken out. If the teacher catches/understands the rationale behind such thoughts, s/he would plan her subsequent presentation of the scientific account to develop/explain such ideas:

14.T	Now, what's the source of this energy?...	Les.2, Part 3
17.S ₆	...Kinetic. Its main source is the kinetic energy	
21.S ₇	From the things inside the resistance	
22.T	Comes from things inside the resistance, what's inside the resistance?	
23.S ₇	(...?) From the wires inside the bulb	

In this excerpt, two pupils came up with the ideas of kinetic energy and the things inside the resistance as sources of energy. Superficially, these can be denied as sources of energy. Following the pupils' thinking about them, however, suggests a different story. The teacher asked earlier about the energy produced by the bulbs and she was thinking of the battery as the primary source of this energy. The pupils' responses suggest, however, that they were thinking about the transformation of the energy in the middle between the electric energy coming from the battery and the light energy produced by the bulb. What happens on the way between these two forms of energy is what the pupils were thinking about, and which also justifies their thoughts about the kinetic energy as a carrier of energy, and what happens inside the resistance as a factor

in producing the lightness. Both ideas then reflect high cognitive processes in thinking about the issue under discussion.

- In other incidents, the talk did not just reveal the recognised misconceptions that the teacher was aware of, but also disclosed the pupils' thoughts behind these misconceptions; ideas that can justify why the pupils are holding those misconceptions and which themselves, actually, can be considered as misconceptions. The analysis of the excerpt below (Les.3, Ex.2) demonstrates this point:

1.T	...Does anyone have another opinion? Let's hear S ₅	I
2.S ₅	It doesn't work. I mean, it will transform from light to heat. It will end up	R _{5.1}
3.T	You mean these electrons, I mean these charges, will change to?	F
4.S ₅	Light #	R _{5.2}
5.T	Light before, and after the light #	F
6.S ₅	Heat	R _{5.3}
7.T	It transforms into heat and then spills out #	F
8.S ₅	Yeah, spill out as heat till the energy of the battery ends up	R _{5.4}
9.T	So these charges that are moving in the wire might finish one day	F
10.S ₅	Yeah, they finish	R _{5.5}
11.T	They finish. So, if I brought this wire, Could it ends from charges in one day?	F
12.S ₅	Miss. The wire doesn't have charges. It's a conductor for the movement	R _{5.6}
13.T	It doesn't have charges. It's just a conductor for charges. So, where do the charges come from?	F
14.S ₅	Aren't they coming from the battery !!	R _{5.7}

The talk in this excerpt was guided to explore the pupils' views in describing the movement of the electric current through the circuit. Here, S₅ is offering her views. She talked about the transformation of energy, and showed high level thinking about the energy from the battery and its transformation to other forms in the bulbs. When the discussion moved to the source of charges, she expressed the expected misconceptions. Through this exchange of talk, one can follow the reasoning path, which led, eventually, to her misconceptions regarding the functions of the wires and the battery. The analysis illustrates that S₅'s misconception, about the battery as a source of energy, comes from a confused perception of the relationship between charges and energy. She believes that the battery is a source of energy and that there is a relation between charges and energy, both of which are correct scientifically. This led her to think about charges and energy to have the same entity. This, in turn, has resulted into two misconceptions: 1) as the battery is the source of energy, so it is the source of charges (turns 11-15); and 2) as the energy produced in the battery will be consumed in the bulbs, so the charges will be consumed and end up similarly (turns 7-10).

The relationship between charges and energy is quite tricky. In discussing the topic of electric circuit through the TI, the focus was directed to the misconceptions regarding the charges; their source, movement and conservation. There was no awareness, in fact, of the influence of such mistaken relation between charges and energy that may cause the

aforementioned misconceptions. It is expected, therefore, that the shortcoming in dealing with the relationship between charges and energy would result in a mistaken or imprecise understanding of the whole system of the electric circuit's work. In fact, the story of S₅ can be followed to show how her conceptual knowledge has developed with the development of the Dialogic talk. The next lesson showed a very interesting and brilliant contribution from this pupil (referred to as S₂ in this excerpt (Les.4, Part 2)), which bears witness to a radical change in her conception as compared to the one that the above excerpt has demonstrated:

13.T	Do you agree or disagree with S ₁ ?	I
14.S ₂	A little...Basically it has - the charges are moving there from the beginning	R _{2,2}
15.T	Where do they move?	F
16.S ₂	They move in the wire^ and go to the bulb	R _{2,3}
17.T	So when the circuit is opened, the charges are moving	F
18.S ₂	No, it's not they're moving. I mean it must - once the switch is off, the charges will meet together and complete the movement around. They move around, but. They move around - they don't move around in the wire	R _{2,4}
19.T	Where do they move around?	F
20.S ₂	I mean they're there – there	R _{2,5}
21.T	They're there. If we take part of this wire and zoom it, and saw the charges there as S ₁ has said. Now you're saying they're moving around, where?	F
22.S ₂	They move there, in their places	R _{2,6}
23.T	Their place ...	F
24.S ₂	No, they're there. It, it - the wire, and once we close it they'll continue their movement. Maybe they were - but when opened - once we close it the movement will keep on	R _{2,7}
25.T	... You're saying they move. How it is this movement?...	F
26.S ₂	They're moving in the wire	R _{2,8}
27.T	In the wire, in which direction?	F
28.S ₂	Umm - maybe - (S ₃ mutters: randomly) No, not randomly. Maybe this direction (Points to certain direction)	R _{2,9} R ₃
29.T	So they're moving in a directed way	F
30.S ₂	No- they can't be --	R _{2,10}
31.T	S ₃ is saying randomly, what do you think?	F
32.S ₂	Randomly?! - No #	R _{2,11}
33.T	So directionally, they move in a directed way	F
34.S ₂	No - I don't know how. Maybe randomly... And after we close the circuit they will move around - before they don't move around	R _{2,12}
35.T	Ok, thanks S ₂ ...	F

In the previous lesson, some pupils offered the idea of the wire as a source of charges. The teacher did not provide any evaluation, and the uncertainty about the source of charges continued throughout that lesson. It seemed that the idea of the wire as a source had found a place in the pupils' minds even without being approved by the teacher. In this excerpt, S₂ is offering a view of the charges not just as existing in the wire but also moving in wire. Surprisingly, S₂ is the same pupil in the previous lesson; S₅ who presented very strongly her view of the battery as a source of energy and denied the wire as to have charges. One of the advantages of the Dialogic talk, therefore, is that it not only gives a chance to some pupils to come up with extraordinary scientific ideas, but also allows other pupils to assimilate those ideas without the confirmation of the teacher.

In addition, when these ideas are challenged through the Dialogic talk itself and in relation to empirical observations (in this case; instant glow of the bulb in the 'big circuit' activity); they develop to a higher level to answer more difficult questions and to reveal more complex scientific facts. S₂'s responses in this example show such development of ideas. She showed hesitation when presenting her remarkable idea, but despite her uncertainty, S₂, in what seems talking to herself and challenging her own thoughts, was coming back repeatedly to the same idea:

- 'They move in the wire' (turn 16)
- 'They're there. There' (turn 20)
- 'They move there, in their places' (turn 22)...
- 'No, not randomly. Maybe this direction...No, they can't be' (turns 28 & 30)
- 'Randomly?! –No...I don't know. Maybe randomly' (turns 32 & 34)

However, such radical development of views was not the case with all the pupils. In spite of long discussions and the justifications presented by some pupils regarding the functions of the battery and the wires, the movement of charges and the carrying of energy; the main misconceptions were still present in some pupils' minds. For example, even for those who started to believe that the wire might be a source of charges, the view of the battery as a source of charges was still persistent:

27.T	Who believes her? (That the wire has charges)	Les.3,
28.S ₈	Yeah, right, cos the wire is a matter and the battery also has charges	Ex.2, Part 2
3.T	So they'll come from the wire? They don't come from here? (points to the battery)	Les.4, Part 1
4.S ₁	I mean when they go there, the battery will give negative charges but will enter from there (points to the part of the circuit near the bulb)	

Nevertheless, the whole picture demonstrates that the first Dialogic discussions were dominated by pupils' misconceptions and mistaken views. More correct and high quality views started to emerge in the discussions later on, to end with these thorough ones dominating the later Dialogic talk. This, in turn, points to the role of the Dialogic talk in supporting pupils' learning by enriching and developing their conceptual knowledge.

To summarise, Dialogic talk appears to have a positive influence on the pupils' understanding, starting from revealing their mis/ alternative conceptions and progressing by developing these conceptions towards the ones more compatible with the scientific view, before being asserted and developed further by the teacher. In the following section, I will look into the data generated specifically to examine the pupils' understanding; what misconceptions or difficulties, if any, are still there, and how scientific and solid the pupils' understanding appears to be. There is also an attempt to trace the findings from the focus group discussion back to the teaching.

A summary of all the issues discussed in this section (7.3) is offered in the concluding chapter (sections 10.1.1 & 10.1.2).

7.4 Commenting on the pupils' conceptual understanding using data from the teaching and focus group's setting

This section addresses the following RQ (section 5.1), following the TI (b):

2.2b What evidence is there of pupils' conceptual understanding, following the observed teaching?

This section presents the findings on the pupils' conceptual understanding obtained from the focus group discussion supported by some of the CT data of the recorded teaching, in addition to the pupils' written responses to the bubble dialogue sheets.

The data of this stage has its peculiarity. It was gathered after a teacher TI took place. Examples of Dialogic talk along with Authoritative one were presented and discussed, and the teaching practice with more Dialogic talk was encouraged. Moreover, through the TI, there was a discussion about some of the documented misconceptions regarding the working of electric circuit (see appendix 4). As referred to throughout the chapter, the CT of this stage was directed to discussing, through Dialogic and Authoritative talk of different levels from the lowest to the highest, the main issues related to electric circuit.

In what follows, I trace the pupils' understanding of the main conceptual points that were raised through the teaching. The analysed lessons were directed to explain the simple electric circuit and how it works in general without going yet into the details of the resistance, voltage, and successive issues of series and parallel circuits. Consequently, the analysis in this section follows the main ideas that the teacher tried to focus on in developing a scientific understanding about how the electric circuit works. It is organised in two parts related to the three conceptions of charges, current and energy on the one hand, and how a simple electric circuit works in relation to the three on the other hand. The analysis is performed with reference to the following scientific information:

- Charges: Charges originate in the circuit and not in the battery.
- Current: When the circuit is connected, the charges are set in motion in all parts simultaneously; Current is not consumed, but conserved. Current (Intensity) is the same everywhere in a simple circuit.
- Energy: The battery is the source of energy; Energy is transferred in the circuit. It is not conserved, but consumed.
- Electric circuit: Electric circuit works as a system, and neither locally nor sequentially; what is happening at one point in the circuit relates to what is happening at other points (not locally), and it is all happening at the same time (not sequentially).

These views are followed in this analysis within two main categories relating to the individual concepts on one hand, and how the electric circuit works in general on the other hand.

7.4.1 Electric circuit in relation to the conceptions of charges, current and energy

Although separated for the purpose of analysis, the three conceptions are interdependent, and identifying their relationships is vital to understand how a simple electric circuit works. If the whole picture of these conceptions is not obvious in the pupils' minds, then they might focus on certain conception(s) and neglect others while explaining the working of electric circuit.

7.4.1.1 Charges

Although there was no direct question about the source of charges in electric circuits through the focus group setting, yet the discussion of the bubble sheets' questions demonstrated quite clearly that the pupils do have the correct scientific conception of the charges as originating in the wires and not in the battery. This can be heard throughout the pupils' arguments on different points, giving the impression that this scientific idea of the source of charges is considered as axiomatic in understanding the working of electric circuit, as none of them was even questioning it:

S₃: ...the battery just organises the charges and supplies them with energy...

S₄: ... but we've said that the charges in the wires move...but basically, the charges are there in the wire

S₂: because they're there basically-charges in the wires...No, cos the charges are there (wires)...It's like what they're saying, the charges are there in the wires, but the energy...

The writing of one of the pupils (S₄), who was trying to offer more explanation of her response to the problem presented in the first bubble dialogue scene on electric circuit (see appendix 3), also demonstrates this conception about the source of charges:

(Writings of S₄)

Muna: and why the closeness of the bulb doesn't affect its brightness...?

Salma: cos the battery do not provide the charges...and the charges are basically there in the wire and move randomly

The group's agreement on the wires as the source of charges can be understood in the view of the long and in-depth discussions that were stimulated throughout the teaching. While looking into the different episodes displayed throughout this chapter, one can easily see how the pupils were able to present their misconceptions regarding the source of charges and how they were given the chance to understand and develop the correct view before the confirmation of the teacher. Here is a reminder of some of the whole classroom discussions on this issue:

T: They finish. So, if I brought this wire, Could it ends from charges in one day?

S_a: Miss. The wire doesn't have charges. It's a conductor for the movement

T: It doesn't have charges. It's just a conductor for charges. So, where do the charges come from?
S_a: Aren't they coming from the battery!!

T: ...S_b, I heard you saying something and then you stopped, what do you think?

S_b: The wire has neutral charges ()

T: S_b is saying that the wire has charges... Is this right?

S_b: The wire is a matter, and every matter has neutral charges

T: So, this wire has charges?... Who believes her?

T: ...so there're negative charges that go in the bulb. Where do they come from?

S_c: Because of the movement. I mean because of the battery, that we put there, there will be a (...?) between the wire and the battery- from the wire they came

T: So they'll come from the wire? They don't come from here (battery)?

T: What do you think S₂ ?

S_d: Maybe the charges are basically moving on their own from the beginning

T: Do you agree or disagree with S₁?

S_d: A little (). Basically it has – the charges are moving there from the beginning... They move there, in their places

However, in spite of the picture of agreement shown by the focus group discussion, the writings for the second scene on the bubble sheets show one of the pupils (S₂) mixing charges with energy, because the two are being confused as originating in the battery:

(Writings of S₂)

Widad: this is right because the battery is the source of the electric charges...

Farah: ...it will decrease cos there is only one battery to produce charges for the two bulbs...

Widad: it will light certainly...cos the source of the charges is there, which is the battery

Widad: of course there will be...cos there are two sources to produce energy (two batteries)...

Yet, despite these mistaken conceptions that appeared in her writings in the bubble sheets, S₂ confirmed her view of the wires as the source of charges on different occasions during the focus group discussion:

S₂: because they're there basically-charges in the wires...No, cos the charges are there (wires)...It's like what they're saying, the charges are there in the wires, but the energy...

As will be clarified later, this pupil has a difficulty in understanding the working of the electric circuit in terms of energy. She was the 'strong opponent' to her group mates in arguing that the bulb closer to the battery will have more brightness because of the more energy reaching it. Her mixing of charges and energy in her writing can be understood, therefore, in the light of her difficulty with the 'energy' conception. Alternatively, it might simply be attributed to the expected imprecision of pupils' writing when expressing their ideas, and also to the informal context of responding to the bubble sheets.

7.4.1.2 Current

In responding to the first scene of the bubble sheets, three of the five pupils in the participating group agreed that swapping the two bulbs would not make any difference to their brightness as the position occupied by the bulb in a simple or series electric circuit does not make any difference. Some of them assumed that the resistance of the green bulb must be higher since it is dim; others predicted that there must be something wrong with the

green bulb or the wire connected with it. They asserted these views in the focus group discussion as already expressed in their writings in the bubble sheets:

S₃: the one whose lightness is dim, its resistance is bigger, so it...the energy particles will loose its energy through that resistance...in the red bulb whose lightness is more, its resistance is smaller

(Writings of S₃)

Muna: ...what do you think if we switch the position? Maybe something would happen

Salma: don't do that...dear, nothing will happen cos the position does not have any effect...the reason that that resistance of the green bulb is bigger than that of the red bulb

S₅: I wrote that the problem must be with the bulb that whether it is damaged or that the wire connecting the battery to the bulb is the one which is damaged

(Writings of S₄)

Muna: ...what do you think Salma if we changed the position of the green bulb so it will be closer to the battery and it will light more

Salma: ...cos it will be the same, the red bulb will light...cos the role of the battery is to provide the charges with energy and organise their movement and the charges are there basically in the wire...maybe there is something wrong with the bulb itself, so it's least bright

In this last extract from S₄'s writing, we can see that in her justification, she was implying that if there were nothing wrong with the green bulb itself, the brightness of the two bulbs (if identical) should be the same because the current is the same everywhere in the circuit. The correct understanding of the current, in terms of the simultaneous movement of the charges and its conservation reflected by its steadiness throughout the circuit, can be spotted quite clearly through her contribution to the focus group argument:

S₄: if we said that the current intensity doesn't change. It's the same the same doesn't change, how do you say that the lightness will differ. It is true ...energy...but we've said that the charges in the wire move, and here also charges and move. It's the same movement

Similarly for S₃- as a part of her explanation of the whole process of how the electric circuit works- it can be concluded that she has a good understanding of the role of current:

S₃: the resistance is...the battery is just organising the movement and ...the closer charges will enter the bulb...

R: if we said the two bulbs are identical and their resistance is the same

S₄: they will have the same brightness...their positions wouldn't...

In contrast, one of the pupils, S₂ was arguing that putting the green bulb in the position occupied by the red bulb closer to the battery would make it brighter, where the red bulb will become dim. However, her mistaken judgment was because of her mistaken understanding of the transfer of energy as it will be explained later. She did not argue about the instant lightness or the constant intensity of the current, therefore, her insistence on the the argument that the difference in lightness is due to the difference in position, looked unjustifiable. Here are some extracts of her responses when arguing about it:

S₅: ...but the length of the wire doesn't affect it

S₂: we didn't say the length of the wire. The energy that...the problem is not the length...

S₄: if we said that the current intensity doesn't change. It's the same...

...S₂: it's right that the current intensity is the amount of charges that pass every second, is the same, but the energy...

R: in the big circuit that S₃ has mentioned, does the bulb light instantly?

S₂: Yes...cos the charges are basically there in the wires... No cos the charges are there and the energy is coming from the battery...the current intensity is the same...

...R: the current intensity differs throughout the circuit?

S₄: No, the current intensity is always the same ...brightness is not the same cos the energy that...

The fifth pupil in the group (S₁) was alternating between the two opposite views:

S₁: I wrote two things, two solutions. The first thing is that the problem is with the bulb...or maybe the red bulb because of its closeness to the battery...yeah, that if we changed the position, the lightness would differ...yeah the charges move, but the battery is closer to this bulb (red bulb)...

maybe they're right cos if we see the street lights, it is the same brightness although the positions are different. So, I think it has nothing to do the position...they (charges) found a place. Before, they were not finding a path to move through...the energy from the battery made them move

It seems, therefore, that the group's pupils do have a good understanding of the current during the course of the teaching content. Following this understanding back to the teaching, we remember that in approaching the electric circuit from the beginning, the teacher asked for the pupils' opinions on five questions (refer to section 7.1), two of them (Q.1 & Q.5) relate directly to the views on current. Interactive and Non-interactive Dialogic talk ranging from low to high levels was exchanged on these questions, before the teacher took control of the discussion to confirm the scientific views. Here, again, is a reminder of some of the extracts on this issue, which can give a glimpse on how the pupils had developed the understanding reflected through the focus group discussion:

T: I want to describe how the electric current moves in the circuit... Describe it, where does it start from? What does it pass through? And Is it definitely that this current moves through the all parts of the circuit or just through certain parts of the circuit?

T: S₃ is saying that the current starts from here, passes, passes, passes till it reaches the bulb and lights. Also the positive charges but don't light up the bulb. Let's write S₃'s answer. So, the path of the current as she said: -Starts from...

T: So, this is S₅'s opinion...And then the charges when consumed up into heat, they'll finish. Ok?...

S_a: No, they're there. It, it – the wire, and once we close it they'll continue their movement. Maybe they were - but when opened - once we close it the movement will keep on ...

T: ...So directionally, they move in a directed way

S_a: No - I don't know how. Maybe randomly... And after we close the circuit they will move around - before they don't move around

T: Ok...The battery will give negative charges...In their way like this, moving, moving, moving, doesn't it take a time?

S_b: No, no, cos when they move – when we switch on they'll enter from there (the part of the circuit near the bulb)

T: So when these moves these will move?... So you do explain by this the Instant lighting?... (see more of this episode in p.34)

In these extracts, one can sense the teacher's emphasis on opening a dialogue with the pupils on the movement of charges and the steadiness of the current. This is in addition to the dialogue exchanged on the source of charges and functions of the battery that is expected to have supported the development of correct conceptions of current.

7.4.1.3 Energy

Examining the pupils' understanding of energy through the focus group setting reveals that all the group pupils, overall, have the correct basic conceptions of the battery as the source of energy; energy as transformed to light and heat in the bulb, and consumed through the course of the electric circuit work. The argument on the problem reflected by the first scene about the effect of the position of the bulb on its lightness demonstrated these basic views of energy explicitly, sometimes, while implicitly, other times:

S₃: ...the battery just organises the charges and provides them with energy

S₂: ...the charges are there and the source of the energy is the battery...

S₁: ...the energy from the battery made them move

S₂: ...the energy will be less, so the lightness of the green bulb will be less

S₄: she is saying that the ones here and here have energy, and the ones here don't have. Why did this light if they don't have energy?

S₂: they have energy, but the energy is weak

The pupils' responses to the second scene made these views more clear as the problem of the scene asks directly about the effect of reducing either the number of the sources of energy (the battery) or the number of the consumers of energy (the bulb) in a certain electric circuit. They all agreed that taking one of the two batteries out of the circuit and keeping the two bulbs would reduce the amount of energy available to the bulbs. They showed, moreover, critical thinking in predicting the brightness of the two bulbs after excluding one battery, given that the question was open in the sense that it did not identify the voltage and power details of both the batteries and the bulbs:

S₂: they light but with less brightness cos the energy is less...

S₃: the same, cos we have one battery and it's enough to light the two bulbs

R: how do you know it's enough?

S₃: cos I saw an experiment with two bulbs. They were lighting with one battery, and we put another battery and the brightness was the same...the brightness will be less if the amount of the energy that they need is not provided by one battery

S₅: maybe the energy is not enough- maybe if it's enough, it will remain the same and if not enough, it will be less (the brightness)

S₄: it is supposed to tell us about the amount of the energy they need, cos if the energy was more than the amount that the bulb can bear, there will be a damage..

...S₁: their brightness will be less with one battery

Their responses to the second part, taking one bulb and keeping the two batteries, also asserted this sort of thinking. This appeared during the focus group discussion as well as in their written responses to the bubble scene. Here, for example, is an extract of the writing of S₂:

(Writings of S₂)

Farah: but how will be the brightness of the bulb in the electric circuit Widad?

Widad: of course the brightness of the bulb will be more cos there are two sources to produce the energy and it will go to one place to the bulb and all the energy will be consumed there

Besides this correct basic conception of energy, S₂ showed difficulty in understanding how energy reaches the bulb or as the pupils put it; how it moves through the circuit from the battery to the bulb. In her response to the first scene, therefore, S₂ argued strongly that the bulb closer to the battery would be brighter because all the energy will be available, so it

will consume as much as it needs, and the remaining energy would go to the second bulb whose brightness will be comparatively less. Here are extracts of her argument through the focus group discussion and a part of her written response in the bubble sheets:

S₂: ...it (first bulb) consumes the energy and transforms it from electric energy to heat and light, and then they (charges) pass through the wires, they don't find another source of energy that feed them, so they will pass- there will be the second bulb and their energy will be less, so the lighting of the bulb will be less

S₂: ...the energy they carry is the problem. It's not about the length of the wire

S₂: it's right that the current intensity...is the same, but the energy that reaches them is not the same

S₂: ...but the energy they carry is different

(Writings of S₂)

Muna: so swapping the positions of the bulbs wouldn't affect the brightness?

Salma: that's right cos the energy in the charges will pass by the first bulb firstly and it will light and to light it will consume the energy and transform it to light and heat, and when the charges come out they'll be having a very little energy so it will be dim in the second bulb

Muna: but how will we solve this problem Salma to make the both bulbs light brightly...?

Salma: we'll put two batteries in the electric circuit one before the first bulb and the other before the second bulb for the charges to pass by the two bulbs and they're carrying energy for the two to light brightly

It can be easily concluded that S₂ pictures energy in her mind as a package carried by charges and distributed to the bulbs, therefore, the first one will get most of the package and the second will get what remains. The charges will then go back to the battery to fill their packages of energy. This process continues until all energy of the battery is consumed in the bulbs after being transformed to heat and light. This picture of energy seemed to be very persistent in her mind, therefore, she insisted on her opinion all the way through the focus group discussion, and was not ready to give it a second thought even when being confronted with other facts:

S₄: it's right that the charges here will go back to this bulb, but basically the charges are there in the wire (referring to the part of wire between the two bulbs)

S₂: but when we close the circuit...the movement...it's right that there are charges here but the energy they have is less

S₄: so they're not moving?

S₁: they are moving but the battery is closer to this bulb (red one)

...S₂: yeah (the current intensity is the same), but...nothing...but the energy reaching them is not the same

R: ...So isn't what S₄ is saying right? The charges in the part between the two bulbs...

S₂: Yeah, but the energy will be less and so the brightness of the green bulb will be less

...R: Ok, if the current intensity is the same, wouldn't the brightness be the same?

S₂: we've said that current intensity is...I mean the energy they'll be carrying is different

S₄: ok, she is saying that the ones here and here have energy, and those here don't have. Why did this light if they don't have energy?

S₂: they have energy, but the energy is weak

R: what makes it weak?

S₂: where the second gets energy from?!

Although S₂ is the only pupil within the group that showed persistently the conception of energy as a package to be filled from the battery, carried by charges and unloaded to the

bulbs. The rest of the group could not present a clear picture of energy that could convince her. Indeed, S₄ was the one who confronted her most and tried to convince her that the two bulbs will have the same brightness. Although she showed good understanding of how the electric circuit works in terms of charges specifically and current generally, yet she did not approach the energy side clearly. To examine more of their views on energy during the focus group discussion, I asked directly about how they perceive energy, and here are some of their responses:

S₃: there are two poles. the battery organises the movement- the charge, where did it get the energy from? Did it enter the battery and got out carrying energy? No, It is there in the wire- everyone has an energy peculiar to it, but this battery is as a source to giving energy for organising the charges

...S₄: the energy is not like organising the charges, cos this as a role, the battery do it
R: how does the battery perform such a role?

S₄: it's right that it organises the movement using an energy that it has. That energy transforms to a movement of charges... a chemical energy that transforms to electrical and used in organising their movement

R: how does it become electrical?

...S₁: when it passes through the wire and lights the bulb

R: why do the charges go to the battery?

S₁: they found a place. Before, they were not finding a path to move through...the energy from the battery made them move

...S₂: it's like what they're saying; the charges are there in the wires, but if the energy is there-they have it, then the bulbs will light before closing the circuit- they are waiting for someone to provide them with energy

Such arguments and views reflect good critical thinking about the nature of the energy going through the circuit (see especially the first extract of S₃ above). Nevertheless, they still illustrate uncertainty about what exactly is the energy carried by the charges and how do these charges get it from the battery in the first place. This is a tricky scientific issue that most might experience a difficulty with. Part from the Dialogic talk that had been exchanged around the third and the fourth questions (what is the source of this energy?; How does this energy reach the bulb?), most of the Dialogic and Authoritative talk afterwards on this point focused on the charges as being everywhere in the wire carrying energy from the battery to the bulbs to be transformed into different forms throughout the circuit. Here is a reminder of some examples of the Dialogic talk that took place on this issue:

T: Now, what's the source of this energy? ...

S_a: ...From the things inside the resistance

...T: So you say, the energy comes from the wires inside the bulb

S_b: The battery gives an electric energy and it passes through the wires #

... T: You said that the battery gives the circuit an electric energy, how?

S_b: Cos it has chemical substances that help producing an electric energy. So...

T: Ok... battery gives the circuit electric energy...electrons will move through the wires. Where is the link between them?...

S_b: ...the energy in the battery will move through the wires

...T: Ok, why did you say the charges here?

S_b: Cos the energy is made up of charges

T: The battery gives the charges a kinetic energy that helps them to pass through. From where these charges are coming basically that it helps them to pass through?

...S_c: -- From the wire...I mean, what I know that the battery gives kinetic energy

T: The charges move... So is the kinetic energy the reason for the lightness of the bulb?

S_a: I mean the charges move

T: They move but...How did the energy reach the bulb?

...S_c: I mean the charges (...?) in the wire, when we open the switch they

T: The charges are basically there in the wires?

Without bringing it to the awareness of pupils and then rejecting it, the view of sequential transfer of energy from the battery to a first bulb and then to a second one is expected to persist in some pupils' minds. Moreover, the 'Bakery-Supermarket' analogy presented to the participating teachers during the TI reinforces the energy-package view that S₂ showed strongly:

T: So, let's answer the question...how did the energy reach the bulb?

S_a: firstly, the charges come to take energy from the battery

T: Yeah, the charges get provided with energy from the battery

S_a: and they work on giving it to the bulb, and then they go back to take energy

T: what do they do in the bulb?

S_a: they upload the energy

T: what does happen to this energy?

S_a: the bulb lights...transforms to light...go back to the battery...

Nevertheless, the teacher in this case used this analogy just to assert and develop the scientific view after the pupils' ideas have been identified. She emphasised that the amount of the bread (representing the energy) carried by the trucks (representing the charges) will be divided equally between two supermarkets, which might have contributed to accepting the idea of equal distribution of energy. It might also be the good understanding of the other elements of the origin of charges, the role of the battery in moving the charges around the circuit and the conservation of current -that the pupils in this case have developed gradually through lots of Dialogic talk- that could possibly have influenced most of the group pupils to give the correct answers. One reason that may be attributed to pupil's unclear view of what energy is, and how it is carried by charges, in addition to its difficulty as a scientific explanation, is the smaller amount of discussion on this point through the teaching as compared to the discussion of the other elements.

7.4.2 How the electric circuit works

The pupils' views on how the electric circuit works as a system are expectedly dependent on their views of the functions of its different parts. For the problem presented in the first scene of the first bubble sheets, three pupils gave correct answer, one gave incorrect answer and one was alternating between the two. It has been suggested in the previous section that all the pupils in general have a solid understanding of how the electric circuit works in terms of the charges, current and basic conceptions of energy. The major difficulty that appeared was

the mistaken or the unclear conception of how charges are taking energy from the source (battery) and delivering it to the consumer (bulb).

This difficulty affected the views of two pupils on how the electric circuit works with regard to the situation presented in the first scene, and led them to incorrect answers. They relied on linear causal reasoning in predicting that the first bulb after the battery gets most of the energy. The teacher paid attention to the pupils' documented misconception about charges in terms of a sequential model. She, hence, supported more activities and Dialogic talk on exploring this issue, and focused on explaining the scientific view through the Authoritative talk that followed. Less attention was paid to explore energy in the light of sequential model and the package-view. Therefore, while the sequential model did not appear in the explanation of the work of the discussed circuit in terms of the flow of charges (current), it was evident in perceiving the flow of energy. It can be said for the pupils who misunderstood it that this mistaken view of the energy interfered with their good understanding of the movement of charges, and also affected their overall view of how the circuit works. The following extracts from the focus group discussion, in addition to the ones I went through in the section above demonstrate how a misunderstanding of one element or a certain point in a whole system (electric circuit) can contribute to a mistaken judgment(s):

S₃: there are two poles. the battery organises the movement- the charge, where did it get the energy from? Did it enter the battery and got out carrying energy? No, It is there in the wire- everyone has an energy peculiar to it, but this battery is as a source to giving energy for organising the charges

S₂: it's like what they're saying; the charges are there in the wires, but if the energy is there-they have it, then the bulbs will light before closing the circuit- they are waiting for someone to provide them with energy

...S₄: wait a sec, you're saying a thing- that the bulbs light before closing the circuit, how do they light? I mean the movement in the wire is not given the chance to move. If we connected (the circuit), there will a movement of attraction. If the circuit is opened, there is still a gap and there will be no attraction and repel, and because of this we have to close the circuit

S₂: ok, so there must be energy from the battery

...S₄: you've said if...I mean the charges are taking energy from the battery and carrying it to the bulb. Ok, if we were taking the red bulb (closer to the battery) out, how the brightness will be?

S₂: its brightness will be stronger

S₄: ok, you've said they (charges) have to carry it (energy), doesn't it take time?

S₂: they're fast in transferring, and the charges are there...(after more argument) ok, the energy is there- don't carry it but it's less

...S₄: if we put a switch between the two bulbs and we closed it and then opened it and then closed it fast, does it light or not?

S₂: lights...why the charges pass by the battery if it doesn't give them energy?!

The pupils' solid understanding of the discussed scientific views and their overall agreement on them, as compared to the confusion of some of them and the uncertainty of others about the energy, might be difficult to justify in the light of the Dialogic talk that took place through the teaching. I tried to show through the sections above that there was less discussion on the entity of energy. Nevertheless, the Dialogic talk was indeed very rich,

thorough and highly controlled by the pupils, therefore, understanding the pupils' difficulty in the light of the exchanged talk does not suggest a convincing explanation. Yet, there are incidents of Authoritative talk that took place subsequent to the entire Dialogic talk on the different issues relating to the working of electric circuit. Looking at the ones directed to explain the scientific views of charges and current below compared to the ones on explaining the views on supplying and transferring the energy (the third below), provides an insight on how the teacher-pupil talk through the teaching might have contributed to the pupils' conceptual understanding and difficulties:

T: Ok, you've said now that the charges move, describe this movement...?

S_a: more than one charge moved in different places

T: at the same time or in different times?

S_a: at the same time

T: at the same time. All the charges moved at the same time...so it means that the charges are coming from the battery or they are there in the wire?

S_b: they're there in the wire

T: they're there in the wire. Once we closed the circuit, what did they do?

S_c: they moved in one direction

T: basically, at the beginning before closing the circuit, they're there in the wire but moving randomly or in different directions...so the ones near the bulb, what did they do?

S_d: they light the bulb

T: they went into the bulb...do you know now why does the bulb light instantly? Does it wait for the charge to come out from the battery and passes through the whole circuit to reach it? Or instantly...

T: So, who is responsible for organising the movement of charges and guiding them in one direction? Whom the one I have here is the motive of this movement?

S_e: the battery

T: the battery, good...if I take the battery out, the movement will be again how?

S_e: randomly

T: randomly, there will be no organised movement. So, the battery is...see the movement of the electrons, see its direction...

... T: what's the kind of energy in the bulb?

S_f: light and heat

T: Good...now what is the source of the energy that lightened the bulb?...the battery, and how did it reach the bulb?

...S_e: there is a chemical substance in the battery and it is who gives the energy to the charges, and so the charges will carry that energy to the bulb to light

T: excellent, the charges will deliver the energy from the battery to the bulb...

In this Authoritative talk, the teacher was trying to develop and confirm the scientific view of the issues that were discussed through many incidents of Dialogic talk. Going again through the extracts from the pupils' argument during the focus group discussion and examining them with reference to the scientific views asserted through this Authoritative talk, demonstrates quite clearly that all the group pupils without exception appeared to have these views. The difficulty reflected by the sequential reasoning in approaching the flow of energy can be expected then not to have appeared if it was discussed thoroughly in the Dialogic talk and/or brought to the pupils' awareness through Authoritative talk. Nevertheless, it was remarkable that some of the group pupils could get to the ideas that the energy must be somehow internal

to the charges and it is distributed simultaneously to all the bulbs, although these ideas were not presented explicitly by the teacher.

A summary of the pupils' understanding on the different issues discussed above is offered in the concluding chapter (section 10.1.2).

7.5 Summary

In this chapter, I presented the results of the first case following the TI. The 'surface analysis' showed many incidents of Dialogic talk in addition to Authoritative talk. Further analysis using the framework revealed some general characteristics featuring Dialogic talk. However, differences among these characteristics in different examples were captured; hence, Dialogic talk has been divided and labelled into three different levels - high, mid and low. Moreover, the results pointed to the pupils' influence in supporting the dialogic practice of the teacher, and the influence of the 'empirical content' in specifying the dialogic level to be high. With regard to the indicators of learning, the results suggest that the Dialogic talk seems to support pupils' learning. Moreover, the results from the focus group discussion demonstrated overall a good understanding of the taught topic, whereas, few conceptual difficulties of the pupils were also revealed. Besides, the results illustrated a resonance between the pupils' conceptual understanding and difficulties, and what happened in the preceding teaching.

The next chapter summarises the content of the analysis chapters of case two, for both stages prior and following the TI.

8 CHAPTER 8: REPORT ON CASE TWO

Two chapters have been written on the data analysis of the second case for the two stages prior and following the TI. Due to limited space, however, both chapters could not be included in this main document and are attached hence as appendices (appendix 2). This chapter reports on the findings from case two by summarising the content of the two chapters following the same structure. The issues arising from the synoptic analysis are essentially discussed around examples of talk, which makes it difficult to provide a clear review of the detailed analysis included in the original chapters, in the absence of most of such examples from this report. Nevertheless, the reader can refer back to the original chapters in appendix 2 to get to more details.

This report begins with an account of the overall teaching approach (8.1) in the two stages. Then, it presents the results from the surface analysis (8.2). It then separates between the two stages in regard to the issues arising from the ‘synoptic analysis’ (8.3 & 8.5) and the results on pupils’ conceptual understanding (8.4 & 8.6).

8.1 The overall teaching approach, stages one and two

Tables 8.1 and 8.2 summarise the overall teaching approach in stages 1 and 2, respectively:

Lesson	The content
1- Matter changes	<i>Physical and chemical features of matter - definitions, characteristics and examples of chemical / physical changes – reflections on the teacher's and pupils' experience of some mountains and caves in their region – detailed information about CaCO₃ – discussion of safety procedures in labs.</i>
2- Changes that cause the formation of rocks (1)	<i>Introducing the practical activity, stating the objective and the apparatus, explaining the formulae of the chemical substances to be used, discussing the nine steps of the experiment (putting sodium carbonate in one test tube and calcium chloride in another one - adding water to each one -mixing the two tubes together-pouring the mixture through a filter paper to get a liquid and a remaining precipitate - adding hydrochloric acid to the precipitate - evaporating the remaining liquid).</i>
3- Changes that cause the formation of rocks (2)	<i>Completing the previous activity - discussing the pupils' observations of each step of the activity - discussing the remaining substances in the last two steps through group discussions and whole class talk - conducting a demonstration of a short activity to differentiate calcium carbonate from sodium chloride (taking the resultant substances from the last two steps, putting them in different glasses, adding water to each one, stirring and leaving them for a while).</i>
4- Changes that cause the formation of rocks (2)	<i>Discussing the result of the previously conducted demonstration to differentiate between CaCO₃ and NaCl. - summarizing the kinds of change in the first two steps of the experiment and continuing with examining the remaining steps; the procedure, the kind of change and the justification behind it - discussing the overall conclusions of the activity - responding to some pupils' questions - relating some of the presented information regarding the usage of acids to everyday experience.</i>

5- Possible evidence (signs) of chemical change	<i>Summarizing the conclusions from last lesson - introducing the second practical activity of the 'evidence of chemical change' through the V-shape -identifying the pupils' opinions of the scientific concepts need to be defined -performing the practical activity (adding some water to red phenol and calcium chloride and observing the temperature – adding sodium bicarbonate to the mixture and observing the temperature again)– discussing observations, results and conclusions regarding the four signs (change in temperature - change in colour – gas rising or formation of bubbles – formation of precipitate) - responding to some pupils' questions.</i>
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Table 8.1: Description of Lessons in C 2, S 1

Lesson	The content
1- Electric circuit: kinds and components	<i>Review of the difference between static and dynamic electricity - pupil's views of the electric circuits; what examples can be found in the classroom? what are the components of simple electric circuit? how it can be drawn and defined – group work and whole class discussion about the elements necessary for the electric circuit to work – discussion of the importance of the wires and if they can be replaced.</i>
2- How does the electric circuit work? (1)	<i>Continuing the discussion of the necessity of wires – initiating the talk about the electric current, the situation of free electrons in conductors before and after the circuit is connected, and the function of the battery in generating this current - exploring the pupils' views of the role of the battery and their suggestions of an experimental design that can demonstrate if the battery is a producer or a pusher of electrons -introducing the teacher's suggestion of such experiment and explaining the justification of how it can be used to reveal the role of the battery.</i>
3- How does the electric circuit work? (2)	<i>Introducing and explaining an analogy that attempts to explain the simultaneous movement of the charges throughout the whole circuit - presenting the teacher-suggested experimental design to investigate the role of the battery - responding to the pupils' argument regarding the idea behind this experiment and the necessity of the battery in the electric circuit - conducting the experiment and discussing the pupils' observation - explaining the scientific view of the role of the battery as a pusher.</i>
4- How does the electric circuit work? (3)	<i>Summarizing the previously presented information – exploring the pupils' ideas of how the battery causes the movement of the electrons - explaining the scientific view of how the battery performs its role through the attraction and repel forces - listening to the pupils' views of the energy transformation in the electric circuit and discussing the structure of the battery and its role in providing the energy needed for the bulb to light.</i>
5- How does the electric circuit work? (4)	<i>Responding to a pupil's view of the possibility for the bulb to light for a short time in an open circuit - listening to the pupils' views and discussing the brightness of two bulbs in one electric circuit and the justification behind it - opening the talk about the conservation of the charges and the consumption of energy in lighting the bulb in the electric circuit - introducing the concept of electric intensity.</i>

Table 8.2: Description of Lessons in C 2, S 2

8.2 Results from the ‘Surface Analysis’: stages one and two

This section addresses the following RQ (refer to section 5.1) prior and following the TI:

1.1 What classes of communicative approach does the recorded CT exhibit?

This case is distinctive from the first one with the incidents of talk initiated by pupils. Judging the class of talk in these incidents followed the CA specifications (refer to 3.1.2). Hence, the quantitative results include the percentages of the different classes from both types of talk; the one initiated by the teacher and the talk initiated by pupils. It is worth

mentioning that the pupil-to-teacher talk was restricted to the Interactive classes whether Authoritative or Dialogic. Although in some incidents, the pupils seemed to control the talk verbally for a long turn, it was always part of an exchange of talk with the teacher and not showing Non-Interactive classes. Besides, in spite of the emergence of the Interactive Dialogic talk in this early stage, the Non-Interactive Dialogic was absent from the five lessons. Interestingly, the results illustrate that all the five lessons witnessed incidents of Dialogic talk. Most of these incidents were attributed to episodes of talk initiated by pupils, with four only initiated by the teacher. Overall though, Interactive Authoritative talk occupied the highest percentage in all the lessons.

Accordingly, this case has not witnessed a 'big' change between the two stages like the first case, primarily because the Dialogic talk was present from the first stage. Nevertheless, there were more incidents of Interactive Dialogic talk and less of Authoritative in the second stage. The Non-Interactive Dialogic talk that was not evident in the first stage did emerge in this stage. Overall, all the analysed lessons of this stage witnessed all four classes of talk as the results below illustrate.

Figure 8.1 reviews the results from the surface analysis for the teaching in both stages, represented through the:

- Graphical representation of the ratios of all observed classes of talk for each of the five lessons in both stages.

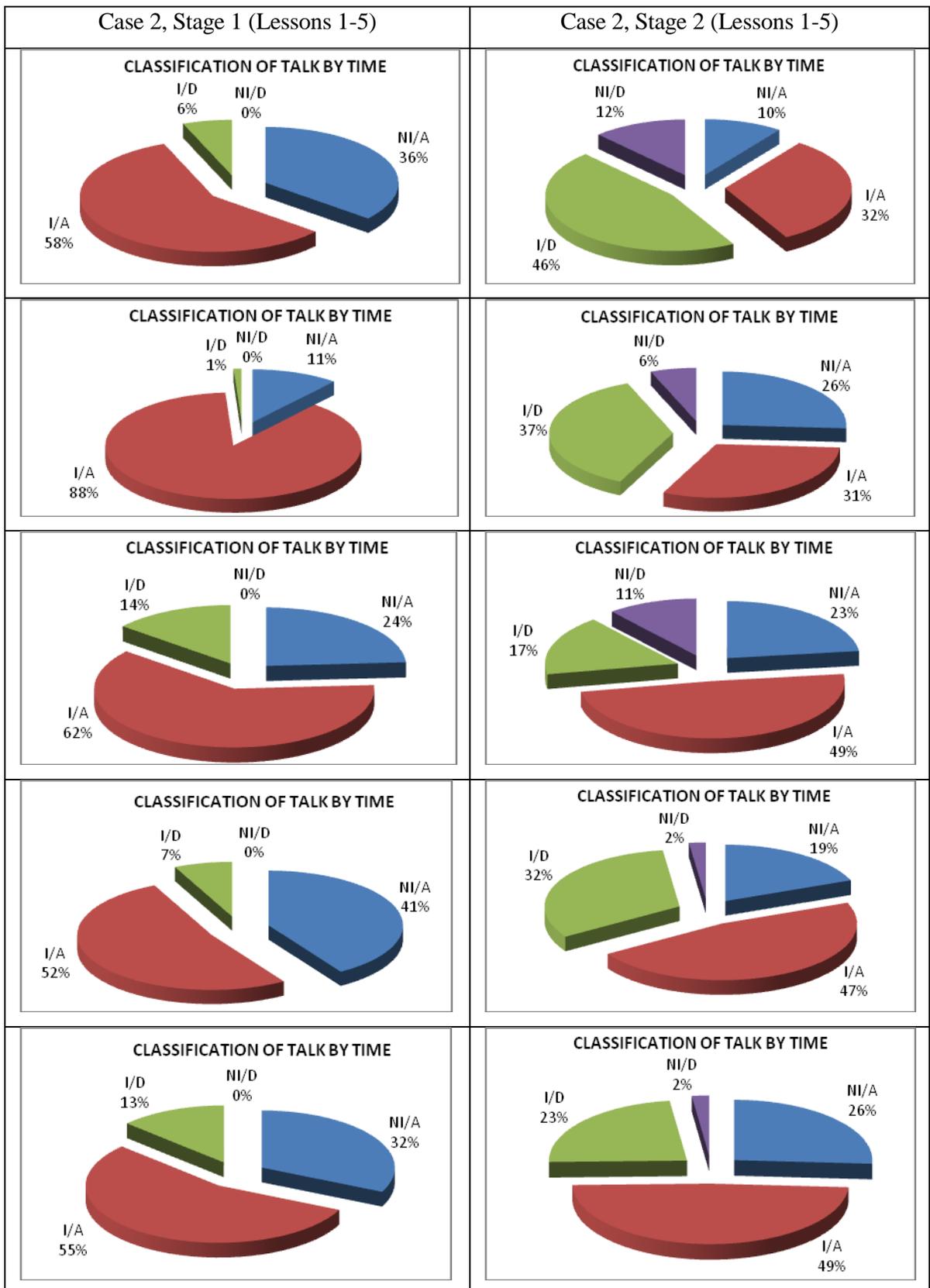


Figure 8.1: The 'surface analysis' results of C2, S1 & S2

8.3 Issues arising from the 'Synoptic Analysis': Stage one

This section addresses the following RQs (refer to section 5.1), prior to the TI (a):

1.2a What features of Authoritative and Dialogic communicative approaches, are revealed by the implementation of the analytical framework?

2.1a What indicators of the potential of Authoritative and Dialogic communicative approaches to support pupils' learning, are revealed by the implementation of the analytical framework?

Given the detailed characteristics of Authoritative and Dialogic talk presented in the two chapters provided concerning the first case, the analysis here does not reiterate the same characterising of talk, but looks into the question relating to:

- How has the teacher reduced the control over the talk in Authoritative and Dialogic classes of talk? (RQ 1.2a).

This is in addition to the two issues discussed through the first case of:

- What has influenced the type and level of the talk? (RQ 1.2a);
- How does the Authoritative/Dialogic talk seem to support/not support pupils' learning? (RQ 2.1a).

8.3.1 How has the teacher reduced the control over the talk in Authoritative and Dialogic classes of talk?

In contrast to the first case that was dominated by a high-level of Authoritative talk in the first stage, this case demonstrated lower levels of Authoritative talk according to the classification in fig.6.2 (section 6.3.2.1). In some incidents the teacher's control reduced to the extent that the talk was classified as Dialogic. There appears to be a number of strategies and factors that have influenced and contributed to reducing the control of the teacher over the talk. Going through the different examples of this stage showed that the pupils could share some control over the talk because the teacher was asking for and listening to the pupils' opinions and listening.

8.3.1.1 Asking for the pupils' opinions and ideas

In different incidents, the teacher seemed to succeed in enticing the pupils to contribute to the issues under discussion through the practice of:

- setting the content to relate to everyday experiences of the pupils;
- asking for the pupils' personal views in relation to everyday content;
- asking for the pupils' personal views in relation to theoretical scientific content;
- asking for the pupils' personal views in relation to empirical scientific content;
- asking for the pupils' personal views in relating empirical to theoretical content;

- asking for different and contradicting personal views;
- asking the pupils to ask.

8.3.1.2 Listening to the pupils' opinions and ideas

More than just asking the pupils for their personal views, the teacher, in many incidents, was showing that she was listening to what they are saying or trying to say. This can be spotted by examining her reaction to the pupils' contributions, mainly through her follow-up moves, supported sometimes with the initiations she was making. This appeared through:

- praising the pupils' contributions without evaluating them and opening the talk for other opinions;
- commenting on the offered responses, accepting them and asking for more contributions;
- commenting on the offered responses, accepting them and elaborating them for more clarification;
- responding to the pupils who asked to present their opinions by giving them the chance to do so;
- following the pupils' responses and asking them for more explanation by elaborating these answers;
- even when evaluating a pupil's response, she was leaving a space for the pupil to contribute to the talk more, if s/he desired.

8.3.2 What has influenced the type and the level of the talk?

Based on the teacher's overall performance prior to and after the TI, one can easily recognise her preference for guided discussions. This contributes to explaining: a) the Dialogic incidences of talk that appeared before the TI; b) the incidents of talk initiated by pupils who found an encouraging environment to pose questions; and c) the less frequent incidences of Authoritative talk of higher level. This attitude seems to have constituted the 'big' influence in determining the Authoritative talk to be of lower levels, and to practise talk open to the pupils' personal views that was classified Dialogic according to the CA. However, there was also the influence of the pupils and the contextual factors that supported the teacher's orientation in guiding the talk or changing its route sometimes. In the original chapter (Ch.11, appendix.2), different examples were offered and discussed to clarify the influence of the pupils and some contextual factors. Here are the broad outlines of this influence as has been presented, supported with one example just for the reader to have a glimpse of what this section is about.

8.3.2.1 Pupils' influence

The examples characterised through the framework in this stage provided evidence of the pupils' influencing the type of the talk and its level by:

a) Reducing the level of the Authoritative talk

Among the many episodes of Authoritative talk with a lower control from the teacher in this stage, there were some examples that demonstrate how the pupils contributed to reducing the authoritative level of the talk. These examples show the pupils taking the lead in controlling the talk and guiding it towards what they themselves think is the scientific point of view. Their influence in reducing the authoritative level by practising more control in guiding the talk appears in the following excerpt (Les.5, Ex.2), for example:

1. T	...Your friend asked about the 'red phenol' as a new concept. Red phenol. An indicator. What do you know about the word indicator? Yes S ₁	I	
2.S ₁	It is - I mean a substance whether a solution or a precipitate	R _{1.1}	
2.T	Beautiful	F	E _v
3.S ₁	Or substances from nature like tea leaves	R _{1.2}	
4.T	Excellent	F	E _v
5.S ₁	This substance () is used to know if the acid is alkali, I mean if the solution is alkali, if it is more than thing	R _{1.3}	
6.T	Just to know acidic or alkali generally?	F	E _L
7.S ₁	Or maybe if it's chemical or physical	R _{1.4}	
8. T	Beautiful. Means it indicates something is happening. Maybe as you said, acidic or alkali. What's important, it shows something, well done. Indeed the indicator in general as your friends said can be a liquid. It can be leaves...	F	E _v

In this example, the teacher opened a discussion about 'red phenol' in response to a pupil's initiated question in a previous episode concerning the meaning of this concept. The talk here stands for the Authoritative type in the sense that the teacher was looking for the scientific view. S₁ offered responses that reflect high cognitive processes and provide the desired scientific view. The teacher followed-up these responses by appraising S₁, elaborating for more explanation and confirming her answers. This excerpt starts with an initiation from the teacher, but goes on without any further initiation (I-R_{1.1}-E_v-R_{1.2}-E_v-R_{1.3}-E_L-R_{1.4}-E_v). S₁ succeeded in keeping the talk with her for the whole discussion. She continued to provide the teacher and the class with various pieces of information about 'red phenol'. She was guiding the talk towards what she thought was the scientific view. By taking such a 'big' share of control, S₁ influenced the Authoritative talk to be of a lower level, besides the teacher's influence in creating an encouraging environment for the pupils to speak their views.

In addition, the pupils' influence appeared to:

b) Influence the talk to shift from Authoritative to Dialogic

c) Influence the talk to shift from Dialogic to Authoritative

8.3.2.2 Contextual factors' influence

This subsection addresses the influence of the contextual factors, focusing mainly on the content, in reducing the Authoritative level of the talk and prompting the teacher to practise Dialogic talk. The nature of the content whether everyday or scientific, theoretical or empirical, simple (easy) or complex (difficult) seems to have influenced the type and the level of the talk by:

- a) Reducing the Authoritative level of the talk
- b) Supporting the emergence of Dialogic talk

8.3.3 How does the Authoritative/Dialogic talk seem to support/not support pupils' learning?

This section explains about the indicators of pupils' learning for both types of talk - Authoritative and Dialogic, supported by highlighting any peculiarities for any of the two types. What follows is a summary of the indicators of pupils' engagement, the quality of questions and responses, and the pupils' understanding.

8.3.3.1 Pupils' engagement

There is no doubt that the teacher's attitude had invited more participation from the pupils. Sometimes, the pattern of discourse was pointing to more pupils participating in the talk (e.g. I-R₁-C₀-I-R₂-C₀-I-R_{3.1}-E_L-R_{3.2}-I-R_{4.1}-E_L-R_{4.2}-C₀-I-R_{5.1}-E_L-R_{5.2}-E_L-R_{5.3}-C₀-I-R_{6.1}-E_L-R_{6.2}-E_L-R_{6.3}-C₀). In other incidents, the pattern was showing one pupil having the chance to exchange the talk with the teacher for several turns (e.g. I-R_{1.1}-C₀-I-R_{1.2}-C₀-I-R_{1.3}-E_V-C_{0(S)}-E_V-I-R_{1.4}-E_V -I-R_{1.5}-I-R_{1.6}-E_L-R_{1.7}-E_V). This participation was not confined to presenting specific scientific information, but was open to the pupils' personal views and everyday experiences. Section 8.3.1 pointed to how the teacher was asking for the pupils' opinions and listening to them. The Dialogic talk were built on these opinions without reference to a 'correct' scientific view. In such talk, the pupils found space to express their thoughts. Sometimes, it was the teacher who was encouraging them to do so. In other incidents, they were themselves motivated to offer their ideas. Although the Authoritative examples were directed to the scientific view, its lower level of authority seems to have stimulated the pupils to speak their thoughts confidently and promptly. In other incidents, it was the teacher who was inviting them to explain more about their views by elaborating their answers until they themselves got to the correct scientific view. On the other hand, however, the teacher was controlling the talk verbally and intellectually for a long time. This was happening frequently in fact. Her control appeared through the initiation move and the Non-Interactive Authoritative excerpts. Whether the Interactive talk was Dialogic or Authoritative,

it was mostly ending up with the teacher lecturing about the scientific view. In such incidents, the pupils' participation was restricted to very short answers.

8.3.3.2 Quality of questions and responses

With regard to the cognitive level of the teacher's questions and pupils' responses throughout the exemplified excerpts of talk in this stage²³, the data has not demonstrated a noticeable difference between the Authoritative and Dialogic talk. The Dialogic excerpts did not show a dominance of high quality moves, nor did the low quality moves seemed to dominate the Authoritative excerpts (see tables 8.3 & 8.4 below). This can be justified by the levels of both the Authoritative and the Dialogic examples of talk. On the one hand, the Dialogic talk was from the simplest level of exploring the pupils' superficial views. The teacher was not exploring the pupils' thoughts in depth, and although there were moves of high quality, they were neither dominating nor were they of the highest cognitive levels of 'Analyse, Create and Evaluate'. On the other hand, the Authoritative examples were of lower level that gave space to some moves of high quality, by being open to the pupils' views. Overall, the quantification of the results points to higher probability for the talk, with lower control from the teacher, to stimulate responses of high cognitive processes, whether they are of low Authoritative or Dialogic.

Examples of Authoritative talk	Quality of questions		Examples of Dialogic talk	Quality of questions	
	Low	High		Low	High
Les.1, Ex.1	1	3	Les.1, Ex.1	2	0
Les.3, Ex.1	2	1	Les.3, Ex.2	2	2
Les.3, Ex.2	3	0	Les.5, Ex.1	0	2
Les.4, Ex.1	6	0	Les.5, Ex.3	11	1
Les.4, Ex.2	0	1			
Les.5, Ex.2	0	2			

Table 8.3: Quality of Questions in I/A & I/D excerpts, C2, S1

Examples of Authoritative talk	Quality of Responses		Examples of Dialogic talk	Quality of Responses	
	Low	High		Low	High
Les.1, Part.2	2	2	Les.1, Part.1	4	2
Les.3, Ex.1	3	0	Les.3, Ex.2	2	2
Les.3, Ex.2	3	0	Les.5, Ex.1	1	1
Les.4, Ex.1	6	0	Les.5, Ex.3	10	2
Les.4, Ex.2	2	1			
Les.5, Ex.2	0	4			

Table 8.4: Quality of Responses in I/A & I/D excerpts, C2, S1

²³ Through the deep analysis, the framework has been applied to examples of talk initiated by pupils. It is worth mentioning that all the quantitative representations in this section of synoptic analysis do not include the data of this type of talk, as it is allocated only to the talk initiated by the teacher.

8.3.3.3 Pupils' developing understanding

The two types of talk together have contributed to disclosing some misconceptions, explaining and correcting them. This was driven by the practice of the teacher to interact dialogically with the pupils to reveal their mistaken views without judging them. This supports the findings from the first case (refer to section 7.3.4.1) that Dialogic talk has a higher probability to reveal the pupils' mis/alternative conceptions. More than revealing misconceptions, the talk with less control from the teacher appeared to result in the pupils stimulating points of discussion that are expected to influence their understanding, if explored and elaborated. In one incident, for example, the teacher asked the pupils which new concepts they wanted to know about concerning the practical activity of looking into the signs (evidence) of chemical change. The first pupil's response was of a low cognitive level as she was asking about a concrete concept of 'red phenol'. The second response was of a high cognitive level because the pupil was thinking of an abstract concept of 'evidence'. In fact, the lack of understanding of this concept - why certain signs are recognised as evidence, and whether to consider them as evidence or not - is a main cause of the pupils' difficulties in determining whether the change is physical or chemical.

The teacher did respond to the first pupil's query about the concept of 'red phenol' (refer to section 8.3.2.1). Unfortunately, she did not open a discussion about the word 'evidence'. She just focused on listing the four signs based on the practical activity, as all the teachers in the pilot and the main study have done; the expected performance. The important point here is that the Dialogic talk in this incident stimulated a pupil's response that could have affected the pupils' understanding positively and significantly, if elaborated. However, Dialogic talk from mid- and high-level (refer to fig.7.2 in section 7.3.3.1) that elaborates the pupils' views in more detail was absent from this stage.

A summary of all the issues presented in this section (8.3) is offered in the concluding chapter (sections 10.1.1 & 10.1.2).

8.4 Commenting on the pupils' conceptual understanding using data from the teaching and focus group's setting, stage one

This section addresses the following RQ (section 5.1), prior to the TI (a):

2.2a What evidence is there of pupils' conceptual understanding, following the observed teaching?

This section comments on the pupils' understanding of the main conceptual issues that were raised through the teaching, focusing more specifically on the pupils' conceptual difficulties with reference to the scientific account, through the two main categories: a) characteristics of physical and chemical changes, and b) evidence (signs) of chemical change (refer to

section 6.4).

8.4.1 Characteristics of physical and chemical changes

8.4.1.1 Change of external/internal features

In contrast to the pupils in the first case, the group of pupils here seemed to be relying on this characteristic in justifying the kind of change more frequently. However, in using the change in features as a criterion, the girls faced the difficulty of recognising the internal features, and deciding whether these features have changed or not, so the kind of change could be determined. This difficulty seems to have been driven by the same two sources of confusion raised through the analysis of the first case (refer to section 6.4.1.1): a) the mix up between the features of substances and the characteristics of physical and chemical changes in changing these features, and b) the attempt to draw a distinctive line between physical and chemical changes in changing the features, that the fact of the chemical change affecting both internal and external features was not evident. In one incident, the pupils were heard talking about the changes, although they had been asked to have a discussion about the features. The teacher realised their mistake, and she told them again that she wanted their views on the features and not the changes. However, she herself mixed them up in another incident. In regard to defining the two kinds of change during the teaching, there was no explicit discussion of the details of the internal and external features and how they are changing.

8.4.1.2 Formation/non-formation of new substance

In general, the pupils did not seem to have conceptual difficulties in using this criterion to judge the kind of change. Quite the opposite, they referred to it most frequently in their justifications and used it confidently in defending their views if challenged. As referred to through the discussion of the first case (section 6.4.1.2), this characteristic is significant in understanding substance changes as all the other characteristics and signs stem from and lead to it. In contrast to the pupils in the first case who seemed not to be applying this criterion, the pupils in this case seemed to be dealing with it as a reference point. Different incidents showed that this characteristic was related to the two characteristics of the change in external and internal features, and ir/reversibility. However, there was no incident through the focus group discussion that showed the pupils referring to this criterion when being confused about the signs. This was explained by their lack of awareness of why the signs of chemical change are considered as evidence, as explained later in section 8.4.2.

In going back to the teaching, it is interesting to find different episodes in which the connection between this characteristic of the formation of new substances and the other two characteristics (change of exterior/interior features & ir/reversibility) is made. However, the

connection between the formation of new substance and the signs of chemical change is not evident.

8.4.1.3 Reversibility/irreversibility

The analysis of the first case showed conceptual difficulties in applying this criterion to judge the kind of changes, and followed different sources of confusions that might explain the pupils' difficulties (section 6.4.1.3). In this case, however, no incident was spotted in which the pupils made incorrect judgment because of this criterion. Quite the opposite, some of the pupils' writings illustrated a good application of this criterion in connection with other characteristics. Moreover, when one of the pupils in the group showed the alternative conception of the change to be chemical if it is not clear how exactly to get the substance back to its initial shape, the rest used this characteristic of the reversibility effectively in their defence. Even when I tried to challenge their presented views, they demonstrated a consistent and solid implementation of this criterion in judging the kind of change.

In following the discussion of this characteristic back to the teaching, the teacher was heard relating this criterion to other characteristics when defining or judging the substance change. The same connection could be heard through some group discussions. Moreover, in defending the physical change of breaking the egg layer, some of the pupils appeared to have a good understanding regarding the meaning and the possibility of the reversibility. This is in contrast to the first case in which the confusion about getting the substance back to its initial external shape and the absence of the possibility point from the pupils' awareness; both were argued to be leading the pupils to make mistaken judgments (refer to section 6.4.1.3). Again, the pupils' more obvious and solid view regarding this criterion could be traced back to the teaching.

8.4.2 Evidence (signs) of chemical change

Similar to the first case, the signs of chemical change were vastly used by the pupils to make judgments on the kind of change in given examples. Interestingly in this case, the pupils' performance in approaching the signs demonstrated more conceptual difficulties in judging the kind of change as compared to their performance in working with the characteristics. Some of the pupils showed mistaken approach of the signs as indicating a chemical change; this was similar to the conceptual difficulties noticed in the first case (refer to section 6.4.2). Most of them showed confusion in dealing with the signs of rising bubbles and change of temperature as evidence of chemical change or not. Such confusion raised the same two problematic paths in understanding chemical change in relation to evidence, that were highlighted through the analysis of the first case: a) the pupils seem

unaware of why the given signs are considered evidence of chemical change, and b) they are not taking into consideration the ‘possibility’ of these signs to appear.

The teaching in this case seems to have contributed to causing this difficulty. Previous to the lesson concerning this issue of the signs, a pupil presented the signs earlier in the context of the first experiment’s conclusions. The teacher approved them without raising the point of the possibility or the justifications behind considering them as evidence. Even when one of the pupils asked for an explanation of the concept of ‘evidence’ in the context of the practical activity of looking into the signs of chemical change (see section 8.3.3.3), no discussion had taken place about it or about why the discussed signs are considered evidence of chemical change. Besides, the pupils’ group discussions demonstrated what has been noticed in the first case of the pupils trying to assign any of the signs to the performed procedures.

A summary of the pupils’ conceptual understanding on the different issues presented above is offered in the concluding chapter (section 10.1.2).

8.5 Issues arising from the 'Synoptic Analysis': Stage two

This section addresses the following RQs (refer to section 5.1), following the TI (b):

1.2b What features of Authoritative and Dialogic communicative approaches, are revealed by the implementation of the analytical framework?

2.1b What indicators of the potential of Authoritative and Dialogic communicative approaches to support pupils’ learning, are revealed by the implementation of the analytical framework?

The stage prior to the intervention showed Dialogic incidents in every recorded lesson. However, this second stage witnessed more Interactive Dialogic talk (refer to fig.8.1) with incidents of Non-Interactive Dialogic talk lacking in the first stage. This section of the synoptic analysis characterises both Authoritative and Dialogic types of talk through the two questions of:

- How has the teacher practised the transition towards more Dialogic talk? (RQ 1.2b);
- How does the Authoritative/Dialogic talk seem to support/not support pupils’ learning? (RQ 2.1b)

8.5.1 How has the teacher managed the transition towards the practice of more Dialogic talk?

The teacher's attitude in listening to the pupils and giving them the chance to ask, has resulted in different examples of Dialogic talk in the first stage. Her awareness of the classification of talk into different types, though, has influenced her towards trying to

practise more Dialogic talk in this second stage. The few examples initiated by the teacher in the first stage were from the low level according to the figure of levels of Dialogic talk (refer to fig.7.2, section 7.3.3.1). They were confined to the type of talk where the teacher explores the pupils' views without going into the details of these views or trying to challenge or develop them. The picture in this stage is different though, with examples ranging from lower to higher levels of Dialogic talk. The first task in this section is to follow how the teacher had guided the Dialogic talk into its different levels by going through some examples. Furthermore, there were examples that were classified Dialogic by the CA, and yet they showed some authoritative features. How these Authoritative features have appeared and what the resultant practice looks like is the focus of the second part of this section.

8.5.1.1 Guiding Dialogic talk into different levels

In overview, the teacher's practice illustrated that she was guiding the talk in a way that encourages and supports the pupils' participation. The pupils' engagement and their contributions to the topics in discussions differed between the levels of the Dialogic talk, though the analysis points to the dominance of the Dialogic talk from the low and mid levels. Dialogic talk of high level was less frequent in this case as compared to the first one. Although the teacher in this case showed a dialogic attitude in listening to the pupils' ideas from the first stage prior to the intervention, she succeeded, in this stage, in practising more Dialogic talk and developing its level, but not to the extent of trying to negotiate and challenge the pupils' views, apart from rare incidents.

The original chapter (Ch. 12) includes examples of Dialogic talk from the three levels of:

1. The low level: Exploring the pupils' ideas superficially
2. The mid level: Exploring the pupils' ideas in detail
3. The high level: Challenging the pupils' ideas

8.5.1.2 Dialogic talk with authoritative features

In trying to practise more Dialogic talk, there were incidents when the teacher seemed to be alternating between authoritative and dialogic behaviours. It was confusing, therefore, to make a judgment about the classification of such talk. Such judgment, in fact, is open for debate because of the tension between the dialogic and the authoritative features that these incidents of talk manifested, and approaching this tension in relation to the context in which this talk is taking place.

The original chapter in appendix 2 includes two examples of such incidents through which I explained the interference between authoritative and dialogic features in the same excerpt of talk. This is similar indeed to what has been noticed in the first case during the second stage

when the teacher was trying to practise Dialogic talk without succeeding in doing so (refer to section 7.3.1). This issue of the interference between authoritative and dialogic features is followed and reflected on in Chapter 9 (section 9.1.2).

8.5.2 How does the Authoritative/Dialogic talk seem to support/not support pupils' learning

For the first case, the teacher practised lots of Dialogic talk to reveal the pupils' ideas concerning the different details of the electric circuit. The talk afterwards was dominated by Authoritative type because she wanted to convey the scientific views. It was possible, therefore, to follow the influence of the Dialogic talk on pupils' learning. For this case, however, this investigation could not be performed for the Authoritative and the Dialogic types separately. This is due to the frequent shift between the two types throughout the teaching practice in this stage. Nevertheless, I try in this section to spot the differences that appear to characterise both types in relation to the investigated issues. I follow then some of the examples of the shift between the different classes of talk to examine their influence on the pupils' learning:

8.5.2.1 Pupils' engagement

Both the Authoritative and Dialogic examples demonstrated different degrees of pupils' participation following their different levels. While in some Dialogic examples, each pupil was taking more turns to talk about her ideas (e.g. Les.1, Ex.2: I-R_{1.1}-C₀-R_{1.2}-E_L-R_{1.3}-E_L-R_{1.4}-E_L-R_{1.5}-C₀), more pupils were participating in other examples with less contribution from each one (e.g. Les.2, Ex.2: I-R₁-C₀-I-R₂-I-R_G-I-R_{3.1}-E_L-R_{3.2}-C₀-I-R₄-C₀-I-R₅-C₀). Similarly, some Authoritative excerpts showed more contribution for each pupil (e.g. Les.4, Ex.1: I-R_{1.1}-E_L-R_{1.2}-E_V-R_{1.3}-E_V-I-R_{1.4}-E_V), whereas in others, more pupils were participating in the talk but with less contribution (e.g. Les.2, Ex.1: I-R₃-E_V-I-R₄-E_V-I-R_G-E_V-I... E_V). Nevertheless, the Dialogic talk was distinguished by its ability to engage the pupils intellectually by asking for their views. Besides, more than inviting the pupils to participate with their thoughts of personal and everyday experiences, the Dialogic talk in most of the examples was centring on the pupils' ideas regarding a scientific content. Discussing such content means that the pupils were encouraged to think deeply to generate views more compatible with the scientific view. Moreover, without any positive or negative evaluation from the teacher through Dialogic practice, the misconception and its opposite scientific correction remain open to other pupils' self-thought and self-argument. This might support the chance for other pupils to be intellectually engaged with the discussed issue, which is less likely to happen if the opinions were closed down by approving or disapproving them through Authoritative talk.

8.5.2.2 Quality of questions and responses

The characterisation of the quality in the Authoritative and Dialogic examples from this case illustrated what has been described in the first case (section 6.3.3.2 & 7.3.4.2). The results here demonstrate also that Dialogic talk supports the emergence of questions and responses of high quality (table 8.5).

In contrast, most of the Authoritative examples were dominated by questions and responses reflecting low cognitive processes (table 8.6). A second observation that has been demonstrated through the analysis of the first case (refer to section 6.3.3.2) and repeated again here is the potential of Authoritative talk to reduce the cognitive level of the starting initiation, where the teacher would lessen the high level of the first posed question to a lower level to increase the chance for the pupils to provide her with the answer she is aiming for.

Examples of Dialogic talk	Quality of questions		Quality of responses	
	Low	High	Low	High
Les.1, Dialg.1	2	6	3	5
Les.2, Dialg.1	0	4	1	4
Les.3, Dialg.1	1	1	1	2
Les.4, Dialg.1	0	8	4	5
Les.5, Dialg.1	4	7	8	1

Table 8.5: Quality of Questions in I/D excerpts, C2, S2

Examples of Authoritative talk	Quality of questions		Quality of responses	
	Low	High	Low	High
Les.1, Auth.1	4	1	2	0
Les.2, Auth.1	3	0	2	0
Les.3, Auth.1	4	0	5	0
Les.4, Auth.1	3	0	4	0
Les.5, Auth.1	1	1	1	1

Table 8.6: Quality of Questions in I/A excerpts, C2, S2

8.5.2.3 Pupils' developing understanding

In general, the analysed examples in this stage illustrate the potential of Dialogic talk for revealing the pupils' views, mis/alternative conceptions and scientific ones. They demonstrate, meanwhile, that in how the teacher was following the Dialogic talk through the shift to other classes has a positive influence on the pupils' understanding in some examples and negative influence in other ones. Different examples are provided in the original chapter (Ch.12, appendix 2) that demonstrate the general observations below:

- In many incidents, it was obvious that the Dialogic talk could reveal the pupils' starting points in approaching a certain issue;
- The shortcomings of the teacher's practice in this stage from Dialogic talk of higher levels in challenging and negotiating the pupils' presented ideas was argued to have

negative influence on the pupils' learning;

- The teacher's practice of not following up the pupils' ideas in some incidents illustrated also how the Dialogic talk in itself cannot influence the pupils' learning positively unless it is reinforced and supported by a meaningful shift to other classes of talk;
- In other incidents, the picture was different with the talk shifting purposefully from one class to another, each with its purpose, content and pattern of moves. In such examples, alternative conceptions could be presented and the scientific view could be slowly and gradually developed from these conceptions by both the teacher and the pupils - a practice expected to influence the pupils' understanding positively.

A summary of all the issues presented in this section (8.5) is offered in the concluding chapter (sections 10.1.1 & 10.1.2).

8.6 Commenting on the pupils' conceptual understanding using data from the teaching and focus group's setting

This section addresses the following RQ (section 5.1), following the TI (b):

2.2b What evidence is there of pupils' conceptual understanding, following the observed teaching?

As highlighted before, each of the analysed lessons in this case witnessed the four different classes of talk (section 8.2), but with very few incidents of Dialogic talk from higher levels as compared to the first case. Similar to the first case, the five analysed lessons were directed to explaining the simple electric circuit as a whole and how it works in general. In this case, there were more activities on the role of the battery and the role of the charges in carrying energy throughout the circuit. In different incidents also, the teacher was directing the talk to relevant issues, but ones which did not relate directly to the taught topic, like discussing, for example, the structure of atoms, what the battery is made of, how a Van De Graaff generator works. Overall, there was less talk on the issues concerned.

The pupils' conceptual understanding is followed through the two categories relating to the individual concepts of 'charges', 'current' and 'energy' on one hand, and how the electric circuit works on the other hand (with reference to the main scientific ideas highlighted in section 7.4):

8.6.1 Electric circuit in relation the concepts of Charges, Current and Energy

In overview, the focus group discussion in this case does not provide enough sufficiently rich data on the conceptions of 'charges' and 'current' because of the high reliance of the interviewed pupils on their conception of 'energy' in explaining their views on the problems

presented by the bubble scenes. The pupils' understanding of the two concepts is therefore discussed in the same section.

8.6.1.1 Charges and Current

Although there were very few incidents in which the pupils referred to the origin of charges during the focus group discussion, it is quite obvious that they all have the scientific conception of the charges as originating in the wires and not in the battery. In fact, the assertion tone with which the pupils were offering such views makes it clear that the battery as a source of charges is not there anymore in their minds. Similarly, the movement of charges was referred to less frequently. More strangely, it has not been conceptualised as a current; not even in a single incident. The 'Current' as a term was totally absent from the pupils' talk. When referred to, implicitly, as movement of charges, this was done mostly within the context of the role of the battery in moving them, and based on their existence in the wires rather than featuring it in the light of its nature of movement. Even when the talk seemed to describe this movement, it can be easily recognised that the description was in terms of the energy. In such incidents, the utterances reflect sequential thinking in approaching the movement of charges. Overall, however, the pupils appear to have a sequential reasoning in approaching the energy as explained later in subsection 8.6.1.2, and that in their mistaken articulation of the movement of charges, they were actually talking about the transfer of energy that is to be carried by charges. Due to the absence of the current from the pupils' argument, the data does not provide any evidence on their views of the scientific ideas of the current as consumed, and being the same everywhere in the circuit. In defending their answers, however, the pupils' views on the simultaneous movement of the charges appear in few incidents.

In going back to the teaching, it appears that the pupils had not had the chance to develop the idea of the charges in the wire and the nature of their movement specifically, slowly and gradually as happened in the first case. Rather, the teacher guided the pupils to recall and think about the structure of matter to bring to their awareness that charges are there in all matter. She then focused on the necessity of the wires to be there in the circuit and whether they can be replaced with any other kind of matter. Without discussing it with them, she displayed a video showing the movement of the charges prior and subsequent to closing a simple circuit, and presented the scientific views authoritatively, featuring the movement of charges in the wire before and after the circuit is connected. Overall, the absence of the conception of the current in regard to its movement and features from the pupils' argument could be traced back to the teaching that also focused less on current. Besides, the pupils' tendency to discuss this movement mostly in relation to the role of the battery only, could be again traced back to the teaching that paid a great attention to this point.

8.6.1.2 Energy

In starting discussing their answers to the question of the first bubble dialogue scene, the pupils' views on energy began to emerge and continued throughout the focus group discussion. All the pupils appeared not to be questioning the battery as a source of energy. There are even incidents in which some of them talk about two functions of the battery as pushing the electrons, and providing them with energy, although the overall discussion reveals that the connection between the two functions was not clear in the pupils' minds. Besides, the pupils showed uncertainty about the nature of the movement and the way with which the energy is transferred. The conception of the energy as transformed to light in the bulb can be concluded from the pupils' continuous connection between the energy provided by the battery and the brightness of the bulbs. Similarly, the conception of the energy as consumed through the course of the electric circuit work could be heard, explicitly and implicitly, in talk about how the electrons distribute energy to the bulbs that consume it.

Yet, different views in relation to the distribution of energy between the bulbs in the discussed electric circuits emerged through the focus group discussion. Some pupils attributed the difference in brightness to difference in the amount of energy reaching each of the bulbs due to their positions. They seem to be utilizing a sequential model in thinking about the distribution of energy. Others appeared to hold to the scientific view that the bulbs will light with the same brightness, if identical, regardless of the position occupied by them. When it came to defending this correct view, these pupils as well as the others, appeared to be struggling with what energy is, and how it is distributed throughout the circuit accordingly.

The captured difficulties could be linked to what happened through the teaching. In discussing the conceptions of charges and current, it has been mentioned that most of the teaching attention was directed to performing and discussing a range of activities on the role of the battery in pushing the electrons and providing them with energy. It seems that the pupils faced a difficulty in understanding those activities and mapping their links to the issues in discussion regarding the working of electric circuit. In addition to the difficulties that some pupils showed in capturing those links, there was rarely a deep discussion (Dialogic talk of high level) of the details of those two functions and the connection between them.

8.6.2 How the electric circuit works

Since the first stage prior to the TI, the teacher in this case appeared to encourage the pupils' questions/comments and responded by listening to them carefully, appraising their contributions and trying to lead them gradually to what she thought answered their questions in accordance with the scientific view. This was the case again in this stage with more

Dialogic talk and more variety of the four classes of talk in each lesson. One might wonder, then, what might have gone wrong that the whole group of participating pupils dismissed the current totally, and showed, to different extents, a sequential reasoning in thinking about the transfer of energy. This resulted in three of them (including the two of high-attainment according to the teacher's records) giving an incorrect answer to the first scene and insisting on it, even though they had been confronted with other contradicting facts. The other three provided the correct answer, and they could defend it, mainly in the terms of equal distribution of energy existing somehow in the first round before the electrons pass by the battery to load their package with energy, but without being able to give a convincing and scientific picture of how the electric circuit works. On the other hand, the pupils who gave an incorrect judgment appeared to be confused even about the instant lightness of the bulb in a simple electric circuit as their mistaken conception of the transfer of energy appeared to be interfering with their overall view as to how the electric circuit works. Even when trying to lead them to focus on the movement of charges, they still found a way to twist their view of how the circuit works to match their judgment.

I found it difficult and confusing trying to relate the views presented through certain incidents of talk to what the analysis above has demonstrated. On the one hand, a correspondence can be noticed between some views that the teacher had reinforced, and those that the pupils have shown, whether correct (e.g. existence of charges) or misleading (e.g. package-view of energy). On the other hand, the pupils' showed a misunderstanding of some issues that had been explained by the teacher through the teaching. Indeed, this was in spite of the Dialogic talk to disclose the pupils' ideas and the Authoritative one to develop the scientific explanation, and the different activities performed and discussed to confirm the scientific view. It is not obvious here what made the scientific account not clear enough for the pupils. It might be that the two main features of the teaching in this stage (offered below) have contributed to the pupils' limited understanding: a) the limitation of Dialogic talk of higher levels along with the teacher's presentation of the scientific views through very long Non-Interactive Authoritative talk throughout the five lessons; b) guiding the talk away from the main point to discuss in detail different and indirectly related issues.

A summary of the pupils' understanding on the different issues presented above is offered in the concluding chapter (section 10.1.2).

The next chapter offers a discussion of some of the study's findings in view of the existing relevant literature, and in relation to the study's aims and research questions.

9 CHAPTER 9: CT DIALOGICITY, TEACHING AND LEARNING: A SYNTHESIS OF IDEAS

So far, the study has addressed the first two questions of each research aim (i.e. 1.1, 1.2 & 2.1, 2.2 in section 5.1) in the analysis chapters. This chapter addresses the last question of each aim:

1.3 Reflecting on the outcomes of 1.1 & 1.2, how can CT Dialogicity be conceptualised both theoretically and empirically, in relation to the existing relevant literature?

2.3 Reflecting on the outcomes of 2.1 & 2.2, how is the pupils' learning influenced by CT Dialogicity?

Both are intended to summarise the study's findings on its main aim of *reflecting on and developing the concept of Dialogicity in characterising the nature of CT in relation to both teaching and learning* (refer to section 1.2). The next chapter provides a summary of the study's findings (section 10.1) and reflect on their implications for further research (section 10.2). In this chapter, I start this task by reflecting on some main results and closely relate them to insights from the literature.

The chapter is divided into three parts:

- The first part (section 9.1) looks into CT Dialogicity in relation to teaching at both theoretical and empirical levels. It starts by suggesting the development of the Authoritative-Dialogic model presented by the CA to examine CT Dialogicity empirically, towards a multi-level one (9.1.1). It moves then to propose the model of 'less-more' dialogic for a theoretical approach to CT Dialogicity (9.1.2). In the two following sections, Dialogicity is linked to other types of CT and to the I-R-F structure (9.1.3 & 9.1.4).
- The second part (section 9.2) focuses on the relationship between CT Dialogicity and learning regarding three issues of: CT characteristics (9.2.1), cognitive level (9.2.2) and common knowledge (9.2.3). Different lines of argument are opened in this section as a reflection on the discussed issues in the light of relevant literature.
- The third part (section 9.3) summarises the findings on pupils' learning in relation to CT Dialogicity and teaching more generally, and reflects on the relationship between the three.

9.1 CT Dialogicity in relation to teaching: theoretical and empirical perspectives

In introducing this work, I set the view of CT Dialogicity as the perspective through which the nature of CT is approached in this study, clarifying that it simply stands as a descriptive

conceptualisation of the ‘dialogic’ label in characterising CT (section 1.1). Afterwards, and in the light of reviewed literature on ‘dialogic’, I explained how CT Dialogicity would acquire various meanings along with different interpretation and use of dialogic (refer to section 2.2.1). Through this review, in fact, I argued that there is a lack of clarity in the literature on how dialogic CT is approached at theoretical and empirical levels, having established that the meaning adopted theoretically, can be different from the interpretation used for empirical investigation.

Discussing ‘dialogic’ at both levels is the approach taken in this study in order to reflect on and develop the concept of Dialogicity as a perspective to characterise the nature of CT. The task of this section is to follow this issue and provide some concluding remarks.

To characterise CT from the Dialogicity perspective at the empirical level, the study chose to work with the ‘Authoritative-Dialogic’ model²⁴ of Mortimer and Scott (2003), and to further characterise its Authoritative and Dialogic types through the developed analytical framework. In one of its outcomes, the results from the application of the framework demonstrated different types of CT that were to be judged as Authoritative and others as Dialogic. Accordingly, Authoritative talk has been viewed along three general levels of high, mid and low (refer to section 6.3.2.1), and the same for Dialogic talk (refer to section 7.3.3.1).

Figure 9.1 puts the levels of both types alongside each other, with the purpose of obtaining a more comprehensive picture of CT Dialogicity developing from the one-level ‘Authoritative-Dialogic’ model of the CA. Thinking about the details in the figure, enriches some discussed issues and draws a number of other speculative lines of discussion. These are:

²⁴ I use the term model attached to empirical and theoretical, when talking about CT Dialogicity at the empirical and theoretical levels. In this use, model refers to a set of ideas/assumptions about CT Dialogicity that;

- when attached to empirical, shapes a (discussed) practical tool to analyse CT;
- when attached to theoretical, describes the concept of CT Dialogicity in its basic components that can be used as a reference for empirical model(s).

Levels of Authoritative/ Dialogic talk	Highest level ----- Lowest level			Lowest level ----- Highest level				
	High-Authoritative talk -----	Mid-Authoritative talk -----	Low-Authoritative talk	Low-Dialogic talk -----	Mid-Dialogic talk -----	High-Dialogic talk		
Frequency of follow-ups	Evaluative moves Dominate	Evaluative moves Persist	Evaluative moves emerge less frequently and comments and/or elaboration appear frequently	Dominated by comments	Dominated by elaboration	Comments and elaboration persist		
Pattern of discourse	The (I-R-E _v) sequence persists	The (I-R-E _v) sequence persists	The (I-R-E _v) sequence emerges less frequently and the (I-R-C ₀ /E _L) sequence appears frequently	The (I-R-C ₀) and the (I-R-E _L -R-C ₀) sequences persist	The (I-R-E _L -R-E _L ...C ₀) sequence persists	The (I-R-C ₀ E _L -R-C ₀ E _L ...C ₀) sequence persists		
Pupils' contribution	Talk is not opened to personal views	Talk is opened to pupils' superficial views	Talk is opened to more in- detail pupils' views	More pupils are presenting superficial ideas	Fewer pupils are detailing their ideas	Fewer or more pupils are detailing and defending ideas		
Features of the talk	-Dominance of the evaluative voice through the initiation and follow-up moves	-Dominance of the evaluative voice through the follow-up move	-Absence of the evaluative voice until the very end of the talk	-Neutral stance of the teacher	-Neutral stance of the teacher	-Neutral stance of the teacher		
	-Movement of the talk towards highly-defined scientific view	-Movement of the talk towards the scientific view	-Movement towards the scientific view at the very end of the talk or through the pupils' scientific views	-Openness to the pupils' superficial ideas	-Openness to the pupils' profound ideas	-Openness to the pupils' profound ideas		
	-Absence of the neutral/challenging voice of the teacher	-Absence of the neutral/challenging voice of the teacher	-Emergence of the teacher's neutral and elaborative (not challenging) voice	-No persistence of the elaborative voice	-Persistence of the elaborative voice mainly through the elaboration follow-up	-Persistence of the elaborative voice through the initiation and the follow-up moves		
	-The teacher controls the talk strongly	-Pupils share little control by presenting superficial views	-Pupils share more control by presenting more in-detail views	-Pupils share less control by presenting superficial ideas	-Pupils share more control by presenting profound ideas	-Pupils share more control by presenting profound ideas		
	A	K	L	M	N	O	P	Z
	(Authoritative			Dialogic) model				
	← Authoritative level ascends			Dialogic level ascends →				
	Less dialogic			(less-more dialogic) model			More dialogic →	
	Dialogicity ascends							

Figure 9.1: Levels of CT Dialogicity

9.1.1 Authoritative and Dialogic: A multi-level model

In having the two schemes of levels of both Authoritative and Dialogic together (fig.9.1), comparing between the two types does not look a straightforward task. Comparing between the highest Authoritative (K), and the highest Dialogic (P) shows two types of talk that are in almost total contrast to each other (table 9.1):

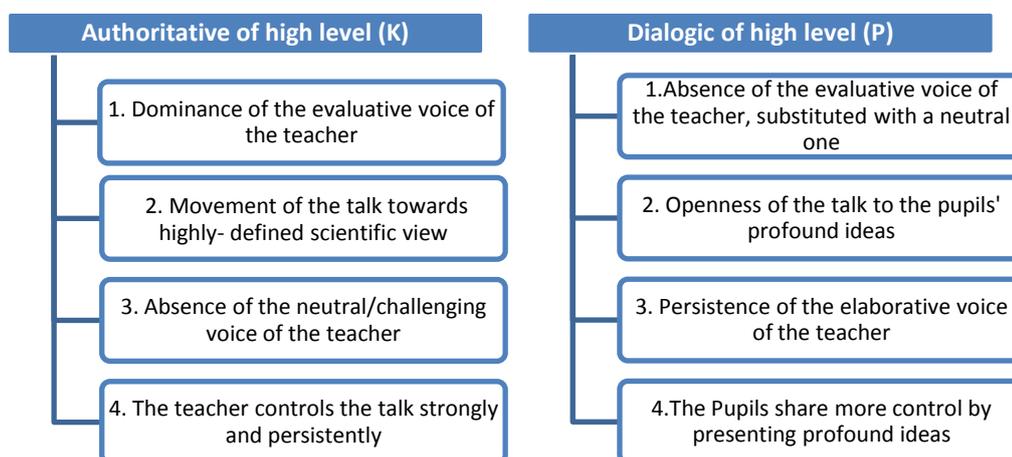


Table 9.1: Difference in characteristics between High A & High D

Whilst the evaluative voice of the teacher dominates the Authoritative talk, not just through the evaluative follow-up but even through initiations and non-interactive parts, this voice disappears in Dialogic talk. The neutral voice is just there as the teacher does not give any judgment on the pupils' contributions, but simply repeats and rephrases them through the comment move. She asks for the pupils' opinions and challenges and negotiates them for deeper thoughts to be presented. She is not the source of knowledge in such talk, but is just a listener for the pupils who provide the whole class with their views, and who guide the talk through their presented arguments. This is the opposite of the Authoritative type, where the teacher controls the talk strongly and firmly by directing it towards highly defined scientific views without asking for pupils' opinions and thoughts. This demonstrates then a 'big' difference between what is to be judged as Authoritative and Dialogic, and no confusion is expected to take place between them.

It is not the same, however, when putting Authoritative and Dialogic of low levels in comparison with each other (M in contrast to N, respectively). There is so much in common between the two (table 9.2) such as the neutral stance of the teacher in responding to the pupils' answers, the openness of the talk to the pupils' ideas and opinions, and the sharing of control between both parties. The difference is 'small' indeed, and the two levels seem to share features more than they are at variance.

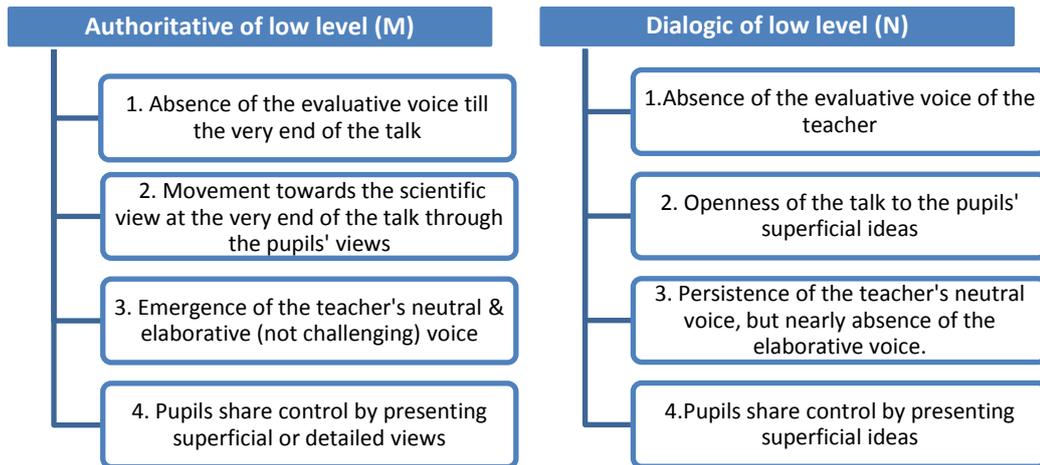


Table 9.2: Difference in characteristics between Low A & Low D

Hence, the comparison between the two types can be approached differently, depending upon which levels are being compared. Having multiple levels for each type suggests, in fact, a new ‘Authoritative-Dialogic’ (A-D) model that is more detailed and flexible than the one proposed by the CA (fig.9.2). This is:

- A multi-level, rather than a one-level model;
- A continuum of Authoritative type of talk (K, L, M) and a continuum of Dialogic type of talk (N,O,P), rather than one level of each;
- A descendant/ascendant level of the features characterising Authoritative or Dialogic talk, rather than features of the same ‘intensity’;
- And overall, a more detailed scheme of CT Dialogicity.

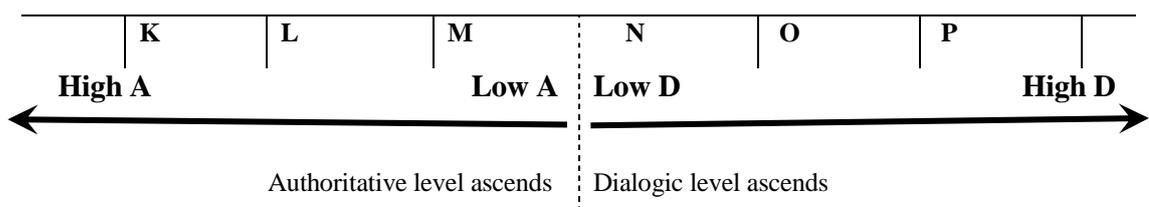


Figure 9.2: A multilevel ‘Authoritative-Dialogic’ model

In defining ‘dialogic’ for empirical investigation then, the CA has provided a workable and purposeful tool that approaches CT Dialogicity within the (A-D) model. Further characterisation of Authoritative and Dialogic types throughout this study has resulted in developing this model towards a more detailed, flexible, multilevel (A-D) model. In fact, Mortimer and Scott in later work with the CA started to capture this notion of different levels. In the context of Dialogic type, they talked about different types in relation to different levels of ‘interanimation’ of ideas; a concept first used by Bakhtin (1981). They wrote that:

“At one extreme, the teacher might simply ask for the students’ points of view and list them on the board. Here the discourse is open to different points of view, but there is no attempt to work on those views through comparing and contrasting. The

teacher's approach involves a low level of interanimation of ideas. On the other hand, the teacher might adopt an approach which involves trying to establish how the ideas relate to one another" (Scott et al., 2006, p. 610)

The talk with low interanimation reflects Dialogic talk of lower level, with its different features of being open to pupils' superficial ideas only, and where the elaborative voice of the teacher is weak in spite of the absence of the evaluative one. The one with high interanimation can be understood within higher levels of Dialogic talk, where ideas are challenged and debated, and the pupils are analysing, arguing and sharing a bigger control in guiding the talk.

The multi-level (A-D) model explains then the difference in characteristics between examples of the same type of talk. However, there is another outcome of the analysis performed in this study for which this model does not seem able to provide a convincing explanation. This is the interference between authoritative and dialogic features within the same excerpt of talk. A striking example on this, comes from case two in the second stage when the teacher appeared to be practising a number of strategies that featured dialogic elements, but the talk was not to be judged by the CA as Dialogic (refer to section 7.3.1). Here is a reminder of those strategies:

1. Setting the purpose of the talk as exploring pupils' views;
2. Setting the content to include personal views and to relate to everyday experience;
3. Listening to the pupils' incorrect views without disapproving of them;
4. Elaborating the pupils' presented views;
5. Inviting different or multiple opinions;
6. Asking questions of high cognitive level.

These strategies featured dialogic elements in respect to the following:

- they opened the space for some different perspectives to be presented, by means of asking the pupils for their different opinions and sometimes elaborating on them;
- they opened the space for the pupils to develop an internal dialogue, by means of allowing different views, asking the pupils to respond to these views, and not evaluating the incorrect ones instantly and directly;
- they opened the space to some extent for a mutual construction of knowledge, by means of inviting the pupils, indirectly, to evaluate each other's views and present what they thought was the correct one, with the teacher assigning to herself only the task of final evaluation.

But then, these three features were opposed by the non-dialogic features of not opening the space for more reasonable differences, more time to negotiate the different views and more effective control over the construction of knowledge. The authoritative practices of evaluating the *correct* responses (or what the teacher regards as scientifically correct)

positively, strongly and instantly, and allocating time to lecturing led to the judgment of Authoritative discourse.

The question here then is, how can the interference between authoritative and dialogic features within the same excerpt of talk be understood in the light of how CT Dialogicity is defined? This raises actually a methodological concern in using the (A-D) model or any similar model for empirical analysis of CT, relating to how an episode/excerpt of talk judged as Authoritative, Dialogic or any categorisation of the empirical model used, is defined in the first place? For instance, one can argue that there should never be CT judged as Dialogic because in taking the whole CT altogether on a certain discussed scientific issue, there would usually be a final evaluation from the teacher to confirm the scientific view intended for the pupils to assimilate (Dialogic is characterised practically by the absence of evaluation from the teacher as indicated in fig.9.2). Judging the type of CT in this sense, can be argued, is a matter of empirical choice.

The next section attempts to follow these concerns by suggesting another model in approaching CT Dialogicity at the theoretical level.

9.1.2 Continuum of Dialogicity: ‘less-more dialogic’ model

One interpretation of the questioned interference of features within the same excerpt of talk, can be that the two types of Authoritative and Dialogic are not quite opposite to each other, and that they must share some kind of basic ground according to which, they are to be seen as a continuum. It would be understandable then to accept that the same excerpt of talk has both authoritative and dialogic features. Yet this study’s approach of analysis in adopting primarily the CA contradicts this view of continuity. The CA refuses this continuity by drawing a distinctive line between the two types of talk, for an operational judgment to be made. It focuses on the teacher’s behaviour in whether to guide the talk towards the one meaning of the scientific view, which necessitates final evaluation from his/her side, or to guide it to different meanings reflecting the pupils’ personal interpretations, which is not to give a space for a final evaluation.

The developed multilevel (A-D) model also has this border line between Authoritative and Dialogic, because it is still based on giving a judgment for empirical use. Although it goes further towards looking at the Dialogicity of talk as a continuum. It is a continuum within the two types rather than between them; an intra- rather than inter- continuum (see fig.9.2).

This argument reminds us of the interpretation in the literature that Wegerif refers to as ‘Dialogic as an epistemological paradigm’; advocated by theorists of Dialogism (e.g. Linell, 2003; Luckmann, 1992; Markova, 1992; Morson & Emerson, 1990; Rommetveit, 1992), as pointed out in the literature review (section 2.3.1). Let us consider again the argument

established there in regard to how two of the Dialogism theorists, Linell (2003) and Morson and Emerson (1992), approached this interpretation:

- They promote the view that any utterance can be perceived as dialogic in terms of some specifications or criteria. Morson and Emerson (1990) state that all the utterances are dialogical in terms of addressivity, responsivity and gener-belongingness as each utterance is directed to another body or thing, comes as a response to the other's situation or utterance, and belongs to the same genre of the other. Linell (2003) explains that any utterance is dialogic because its meaning is dialogically constituted as it is made in dialogue in reference to its context that is itself dialogically constituted and appropriated.
- Yet, these same theorists argue that despite the conceptualisation of all the utterances as dialogic in nature, there are differences in how dialogic different utterances are. Morson and Emerson, for example, argue that utterances can be seen as more or less dialogic in relation to the multi-voicedness and openness of the utterance. Linell (2003) talked also about monological vs. dialogical discourses, where the monological is the product of 'monologising' activities.

This means that although, within this interpretation, every utterance is seen as dialogic, different utterances/talk are considered as to be less or more dialogic than each other. This suggests then a model of 'less-more' dialogic in characterising the Dialogicity of talk, where the Dialogicity of certain talk does not stand on its own, but in comparison with other talk that is less or more dialogic. In this sense, Authoritative and Dialogic can be approached as follows:

- Authoritative talk is '*less*' dialogic than Dialogic talk;
- Dialogic talk is '*more*' dialogic than Authoritative talk.

This supports the continuity view of Dialogicity because it does not draw any border line between Authoritative (as less dialogic) and Dialogic (as more dialogic), and suggests that the two are to be compared in terms of each other. This is in contrast to the 'A-D' model of the CA that refuses this continuity.

This is then a situation with a paradoxical difficulty, which can be resolved by taking two simultaneous positions:

- Adopt, theoretically, the continuity view in realising the concept of CT Dialogicity
- Refuse, empirically, the continuity view in characterising CT Dialogicity

In other words, I realise that CT Dialogicity needs to be kept analytically apart, requiring the specification of distinctive criteria that can detail it to provide a practical tool to analyse CT and judge it in view of defined dialogic-driven categories. Meanwhile, the continuity view

provides a base for shaping a theoretical model for approaching the concept of CT Dialogicity. I consider that the significance of the continuity view as a base shows in the following envisaged features of the 'less-more' dialogic model:

1. It gives Dialogicity a relative meaning determined by the 'less' and 'more'. It is not bound to specific defined categories as the Authoritative and Dialogic in the CA, for example. Rather, it stands as a flexible and open description of the nature of some CT in comparison to what appears as a different type of CT in terms of its multi-voicedness, openness, authority, power and control...(any specification or criteria through which the continuity view is chosen to be followed).
2. It establishes a link between the different types of talk compared along the continuity line. To clarify, understanding Authoritative as Authoritative that stands in opposition to and as distinctive from Dialogic, as suggested by empirical models (e.g. (A-D) model of the CA and multilevel (A-D) model, in this study); such understanding does not suggest a link between the two. However, perceiving it as less dialogic than Dialogic type in the light of the continuity view, does provide an approximation of an existing relationship in real situations.
3. The relative meaning of Dialogicity and its openness to any chosen specifications or criteria in approaching the continuity, can be re-adjusted and re-interpreted to be applicable for empirical use. Basically in fact, I do not perceive the continuity meaning embedded in the less dialogic/more dialogic comparison, constrained to practical classifications related to the label of 'dialogic'; I believe rather that it can be extended to other classifications of the types of CT, as argued in the next section.
4. The continuity base of a theoretical approach can also be used to understand and reflect on the insights gained from working with existing practical tools in analysing the nature of talk. More to the point, this study is attempting to examine the relationship between CT Dialogicity and learning, but the crucial question in the context of the current discussion is, can learning be understood and explained in line with the discontinuity view employed by the empirical models? In the next part of the discussion of CT Dialogicity in relation to learning, I argue that the continuity view is especially needed in approaching this relationship.

In summary then, the figure of levels (fig.9.1), declares two positions in approaching the concept of Dialogicity as a perspective on characterising the nature of CT, identified by a constitution of theoretical and empirical models:

- There is the multilevel 'A-D' model that defines CT Dialogicity for empirical investigation through a continuum of Authoritative levels of talk, and a continuum of

Dialogic ones, with definite criteria to differentiate between the two. This is built on the (A-D) model of the CA (fig.9.3).

- There is the ‘less-more dialogic’ model that is based on a continuity view in approaching CT Dialogicity; an approach that can be used as a reference for empirical model(s), due to the relative and open meaning of CT Dialogicity it offers, and its approximation of the relationships between the types of talk in comparison (fig.9.3).

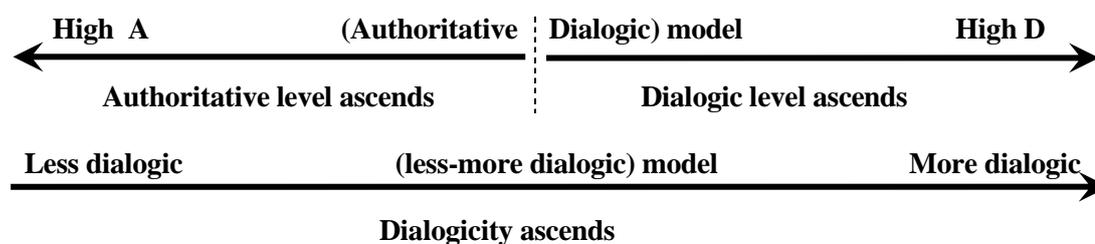


Figure 9.3: The ‘multilevel’ A-D & ‘less-more dialogic’ models of CT Dialogicity

Having started the argument on the features and the suggested advantages of the ‘less-more’ dialogic model, I argue in the next section that the different labels used to describe CT throughout various studies can be approached in the light of the CT Dialogicity continuum. In doing so, the study promotes the prospect of using the continuity view to CT Dialogicity within the ‘less-more’ dialogic model-derived from the Dialogism theory and interpreted from Bakhtain’s writings in characterising the Dialogicity of talk- to perceive the different categories within which CT has been described through various lines of research in science education specifically.

9.1.3 Types of talk along the ‘less-more dialogic’ model

The results of this study demonstrated levels from K to P; three for each of the Authoritative and Dialogic types. The six together illustrate examples of talk that ascend in their Dialogicity starting from K and reaching to P. Choosing the letters K...P to refer to those levels is meant actually to point to the possibility of the talk reaching further levels, the lowest extending to A, and the highest extending to Z. Within the theoretical model of ‘less-more’ dialogic, this flexible scheme of CT Dialogicity extending to A and Z is meant also to reflect the potential of the model to attend to different labels of talk if it is to be understood from the perspective of Dialogicity. I started this argument in the previous section, explaining that a theoretical model of CT Dialogicity can be used as a reference, not only for empirical tools interested in dialogic-related classification, but also for those tools concerned with other labels in describing the nature of CT. What is of interest to me here actually, is to argue that the continuity view in realising CT Dialogicity can contribute to bridging the research work in characterising the nature of CT.

Firstly, at the beginning of this report, I pointed out the difficulty of determining the position of dialogic talk in the context of the other labels of CT that seem to interrelate with it in meaning, and in research as well (section 1.2). To clarify, looking into some defined labels in describing the nature of CT found in the literature (as the ones listed below) brings to mind the same specifications/criteria that were anticipated in approaching the continuity of CT Dialogicity - the multi-voicedness, openness and authority, for instance (section 9.1.2 above). These labels are taken just as examples to carry on the intended argument, not meant in any way to establish particular categories or listed definitions. In fact, they have been chosen specifically for two simple reasons: a) they are common categories of CT widely used in literature, and b) they are all taken from the same source of Fisher (2007, p.618):

- *Instruction*: telling the pupils what to do, and/or imparting information;
- *Monologue (Lecture)*; one person, speaking, without engagement with others;
- *Recitation*: teaching through questions assigned to test or stimulate recall;
- *Conversation*; talk with others characterised by uncritical sharing, lacking depth and challenge, speaking and listening at a low level of cognitive demand;
- *Discussion*; exchanging ideas with others, to share information or solve problems;
- *Argument*: where individuals views compete and monologic viewpoints are aired;
- *Dialogue*: exploratory talk with others, cooperative enquiry with dialogic space to agree/disagree, challenge, question, appeal to reason and allowing possible self-correction

Now, if we try to think of these labels in accordance with the meanings assigned above, and in the light of the ‘less-more dialogic’ model, then we might end up with a scheme such as represented by fig.9.4 below:

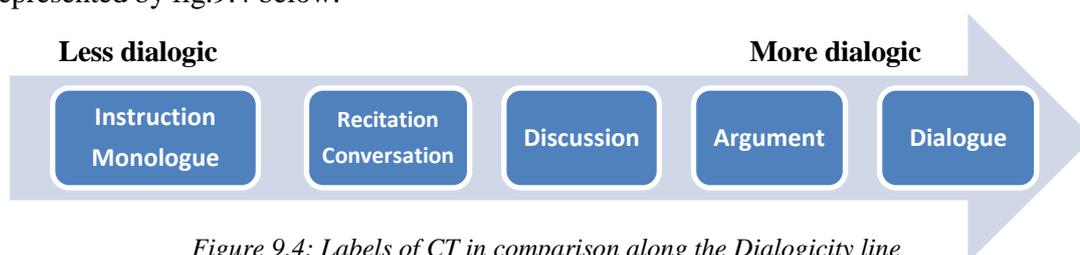


Figure 9.4: Labels of CT in comparison along the Dialogicity line

This scheme is not a ‘fixed’ distribution of labels of talk along the Dialogicity line; rather it is a speculation of the Dialogicity of the displayed labels in comparison to each other, as this model is built primarily on giving Dialogicity a relative meaning connected to the types of talk being compared (e.g. Discussion is more dialogic than Monologue (*in terms of its openness to the pupils’ views and share of control, for example*), but it is less dialogic than Argument). The interference between the details and characteristics of these different labels is undeniable, as well as the relatively different meanings assigned to them by various studies and different researchers. One can argue, accordingly, that certain labels of talk should be moved along the

line of Dialogicity to share another label slot or even replace it...etc.

Certainly such points of argument are justified. Certainly also, there are peculiarities for each label, but the Dialogicity conceptualisation within the ‘less-more dialogic’ model, as featured in the previous section, has the advantage of broadness that allows for the opposites, of ‘monologue’ and ‘argument’ for example, to be put together and to be described as the former is less dialogic than the latter. It has also the flexibility advantage that allows even for the same label of talk to be put into different less/more dialogic types; for example, using two categories of argument, closed argument (led to a certain view) and open argument (not led to a certain view), where the former will be less dialogic (fig.9.5). Interestingly moreover, Authoritative talk of low level can be considered as more dialogic than Dialogic talk of low level in the terms of its openness to the pupils’ views and the persistence of the elaborative voice of the teacher, for example (refer to fig.9.1).

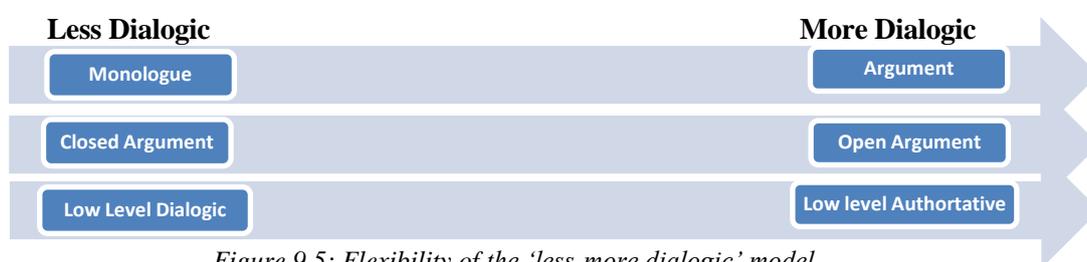


Figure 9.5: Flexibility of the ‘less-more dialogic’ model

Hence, as the continuity view within the ‘less-more’ dialogic model can be used to provide some kind of a theoretical backing for existing empirical models attached to dialogic label like the (A-D) one. It can also be used as a reference to develop empirical models or practical tools in working with other types of CT, like the suggested one for open/closed argument, for example. Indeed, I believe that a theoretical model for looking into the nature of CT, whether the Dialogicity model promoted in this study or any suggested alternative theoretical model, is needed; one which offers the possibility of taking the whole of CT as a unity, providing a shared ground that allows us to think about the different types of talk in relation to each other.

Going back to the literature review, it can be noted from various remarks that the perception of different types of CT from the Dialogicity perspective has occurred in different studies and by different researchers, albeit implicitly. Nystrand (1997) used the label of discussion (with the conventional meaning pointed out above) to identify the paradigm of ‘dialogically organised instruction’ (section 2.2.2). Alexander (2008c) used the labels of discussion and scaffolded dialogue as the types of CT more likely to meet the criteria of dialogic teaching (section 2.2.2). Wells (1999) articulating dialogic teaching as inquiry, described the talk as progressive through which students’ ideas are refined and worked on (section 2.2.2). Dialogic teaching/instruction cannot be approached in isolation from CT Dialogicity however it is conceptualised. Using such labels of discussion and scaffolded dialogue in the

mentioned contexts then, means that these labels have, in fact, been approached from the Dialogicity view.

Furthermore, in describing the meaning of dialogic as ‘pertaining to dialogue’, Wegerif (2007, p. 14) argued that the term has been utilised in the “contexts where other terms like ‘collaborative learning’ or ‘discussion’ or ‘social interaction’ or ‘community of inquiry’ were previously used. This supports again the claim that perceiving some labels of talk in view of CT Dialogicity has been done implicitly, although not declared and not approached through a clear theoretical model.

I conclude this argument by making use of the suggested theoretical model in approaching one of the issues that has been raised in this study and in which research is increasingly interested, that is ‘dialogic teaching’. Descriptions like the ones presented by Alexander (Alexander, 2008a; 2008b, 2008c) and Fisher (2007) in ‘Dialogic teaching’ stated below, do contribute to explaining dialogic teaching:

“Dialogic teaching refers therefore to the kinds of verbal interaction that provide cognitive stimulus, expand consciousness and enlarge the dialogic space for thinking in children’s minds” (Fisher, 2007, p. 617)

“I submit that teaching which is dialogic rather than transmissive, and which provides the best chance for children to develop the diverse learning talk on which different kinds of thinking and understanding are predicated, meets five criteria. Such teaching is: collective... reciprocal... supportive... cumulative... purposeful” (Alexander, 2008a, p. 105)

However, I think that such accounts provide a general description of this notion, that does not seem applicable for empirical use, through which teaching can be judged as dialogic or not. It can be argued, indeed, that in the absence of a more comprehensive picture of CT Dialogicity, articulation of dialogic teaching is less likely to reflect a convincing view of teaching in practice. I argued through the literature section that dialogic talk seems to be confused with dialogic teaching (section 2.2.2), so dialogic teaching appeared in different studies to follow the judgment given based on the practice of more incidents of dialogic talk. This is what has resulted eventually in viewing teaching along the ‘dialogic/not dialogic’ polarisation; a limited approach argued not to reflect a realistic and productive view of teaching, and which would confuse (and maybe did) the investigation of teaching and learning in terms of the attendant CT in general, and in the light of its Dialogicity in particular.

Research into CT relying on a more dimensional view of CT Dialogicity within the CA four classes of talk offered by Mortimer and Scott (2003), has led the investigation of dialogic teaching to a more realistic view demonstrating, for example, that ‘dialogic teaching’ is to meet five conditions, the most important of which is:

Dialogic teaching: involves shifts in communicative approach

- From dialogic to authoritative approaches as the discourse is ‘closed down’,
- From authoritative to dialogic approaches as the discourse is ‘opened up’. (Scott, Ametler, Mercer, Staarman, & Dawes, 2007, pp. 19-20)

As pointed out before (section 2.2.3.1), such a conception of dialogic teaching takes a progressive step by establishing that dialogic teaching is a *tension between Authoritative and Dialogic types* of talk that have been ‘measured’ empirically. In line with this connection then, dialogic teaching in accordance with the empirical multilevel (A-D) model developed in this study, can be perceived as a *tension between the different levels of Authoritative and Dialogic types*. However, can dialogic teaching not be approached by means of other labels used to describe CT, such as lecture, discussion, argument...?

Having the different forms of talk along the Dialogicity line in fig.9.4 suggests that in labelling and criticising teaching using one or even two of the stated forms, we do not do justice to the research on teaching and learning in general and to teachers in particular. Teaching is so complex and dynamic that it can be all of those forms together in principle (the teaching in stage two is actually an example of such teaching, showing six different levels of Dialogicity). Having agreed that this is so, then ‘dialogic teaching’ can be looked at as a *tension between less and more dialogic types of talk*, to whatever categorisation these less and more dialogic labels are attached.

Although the next section takes the discussion in a slightly different direction, it is still concerned with characterising CT from the Dialogicity perspective by exploring how the I-R-F pattern has the potential to attend to forms of talk varying in ‘how’ dialogic they are, if approached differently.

9.1.4 I-R-F pattern along the Dialogicity line

The triadic coding of moves of the I-R-F, which Sinclair and Coulthard introduced in 1975, is the ubiquitous exchange structure that all studies of classroom discourse have agreed on, Wells (1999) claims. It seems, however, that describing the third move of F as corresponding to *feedback* from the teacher by Sinclair and Coulthard (1975), reinforced by its description as *evaluation* by Mehan (1979), gave somehow an impression of a negativity to the structure ending with the F move, as limiting the pupils’ contribution and discounting their role. Lemke’s (1990) call for the dismissal of what he names triadic dialogue I-R-F in teaching practice, taking F as an evaluative move, is well known among researchers in CT studies. Disregarding the fact that Sinclair and Coulthard were describing the structure of talk, not the content, Lemke among other researchers seems to have put the blame on the I-R-F structure rather than on the pedagogy in which this structure has been employed. Again,

conceptualising the forms of discourse within such a narrow view of the I-R-F structure, does not do justice to the structure itself, as well as to the teaching that is to be denied its implementation altogether.

However, there were other researchers like Newman, Griffin, and Cole (1989) and Mercer (1995) who argued that the I-R-F structure is functionally effective in serving some goals of education such as eliciting pupils' misconceptions, monitoring their understanding and guiding their learning. Soon after, the view of this structure developed further when Wells (1999) declared that:

“in itself, triadic dialogue is neither good nor bad; rather, its merits - or demerits - depend upon the purposes it is used to serve on particular occasions, and upon the larger goals by which those purposes are informed” (p.169)

Following this position, other researchers besides Wells himself, started to examine the functions of the moves within the whole structure of the I-R-F, given that different functions would mark different contributions towards the pupils' learning (Barnes, 1976 cited in Wells, 1999). Paying special attention to the third move, Wells argued that:

“when the third part of the structure is characterised as follow-up, rather than more narrowly as evaluation, there are compelling reasons for seeing the IRF sequence as the prototypical action structure for the achievement of the overarching goals of education” (p.206)

The function of the third move has indeed captured more interest in research, and is used sometimes to mark different modes of teaching in relation to its forms of talk. For example, Mortimer and Machado (2000) used the nature of the F move, whether evaluation or elaboration, as a distinctive criterion between univocal (authoritative) and dialogic (internally persuasive), respectively. In a more complex classification, Nassaji and Wells (2000) classified the I-R-F structure on the basis of the function of the third move whether evaluation, justification, comment, clarification, action or metatalk, with further sub-categorisations, to characterise what they call teacher-student dialogue. The pattern of moves, itself, has also been used to differentiate between forms of talk. For example, Mortimer and Scott (2003) made a link between the I-R-F-R-F- chains of interaction and the dialogic approach to teaching, in contrast to the I-R-E- pattern that characterised the Interactive/Authoritative talk (refer to section 2.2.3.2).

The characterisation of the talk throughout the analysis of this study provides, in my view, a more detailed insight on this issue. The results illustrated several differences between the different forms of talk not just in regard to the functions of the three moves of I, R & F, but also in regard to their quality, as well as their frequency and order. This means that the different forms of talk characterised in this study along the Dialogicity line can be conceptualised in terms of the *frequency, quality, function and pattern of moves*.

Table 9.3 displays these points of conceptualisation between the high levels of Authoritative and Dialogic talk. I chose to highlight only the high level from each type because of the big difference between the two, making it easier to follow the line of argument that this section is trying to tackle. In other words, there is an attempt here to show how the *frequency, quality, function and pattern of moves* mark the forms of talk varying in their level of Dialogicity, and surely the comparison between the highest from each type will ‘hit’ the point. This portrait of differences illustrated by table 9.3 does not provide a re-evaluation of the I-R-F structure to advertise its appropriateness and significance for certain purposes and on certain occasions, as there is no doubt in today’s research about its merits. However, arguing that the structure serves certain purposes means that it is still bound to certain types of teaching, more likely the so called, traditional, teacher-guided ones; “The triadic dialogue, which is typical of traditional teaching, is...” (Chin, 2006, p. 1316).

Move, Frequency, Quality, Function	High level Authoritative Talk	High level Dialogic Talk
Initiation (I)	<ul style="list-style-type: none"> • More frequent • Close-ended; the teacher knows the answer • Low cognitive skill, ‘How’ & ‘Why’ questions disappear • Directed to defined scientific view; not opened to pupils views • Evaluative frequently 	<ul style="list-style-type: none"> • Less frequent • Open-ended; the teacher does not know the answer • High cognitive skill, ‘How’ & ‘Why’ questions persist • Opened to pupils profound view • Neutral & Explorative
Response (R)	<ul style="list-style-type: none"> • More pupils offer responses • Short, brief answers • Present what the teacher wants to hear of the scientific view • Low cognitive skill • Opened to ‘guess’ answers • Little contribution • Guided by the teacher talk 	<ul style="list-style-type: none"> • Less pupils offer responses • Long, extended answers • Present pupils’ opinions /analysis of the scientific view • Mostly High cognitive skill • Not-opened to ‘guess’ answers • Big contribution • Guide the talk
Follow-up (F)	<ul style="list-style-type: none"> • Evaluative move dominates • Judgmental; Immediate, Direct, Strongly expressed • Not Elaborative • Directed to the scientific view • Long, lecturing feedback • Guide the pupils’ responses 	<ul style="list-style-type: none"> • Comments and Elaborative moves dominate • Non-Judgmental, Neutral • Elaborative; challenging & negotiating • Directed to pupils’ opinions • Short feedback • Guided by the pupils’ responses
I..R..F Pattern	<ul style="list-style-type: none"> • I-R..Ev pattern dominates • Controls & Limits the pupils’ contribution <p>e.g, I-R₁-E_v-R₂-E_v-R₃-E_v-I-R_{4,1}-E_v-I-R_{4,2}-E_v-R₅-E_v-I-R₆-E_v</p>	<ul style="list-style-type: none"> • I-R-C₀,EL-R-C₀,EL...C₀ pattern dominates • Controlled by the teacher & pupils’ contribution <p>e.g. I-R_{6,1}-I-R_{6,2}-C₀,E_L-R_{6,3}-C₀-I-R_{6,4}-C₀-I-R_{7,1}-E_L-R_{7,2}-E_L-R_{7,3}-I-R_{8,1}-C₀-R_{8,2}-E_L-R_{8,3}-C₀</p>

Table 9.3: The I-R-F between High A and High D

Such an approach restricts the I-R-F structure to certain forms of talk; the ones likely to be described from the Dialogicity perspective as less dialogic. However the differences in table 9.3 suggest that this is not the case. The format of I-R-F structure is applicable to more dialogic forms of talk. The patterns of dialogic talk still exhibit the I-R-F structure. This means that its credit as a structure of CT does not stem from its functionality for certain purposes through certain forms of talk, but from its potential to attend to the different forms of talk, ranging from the less to the more dialogic along the Dialogicity line. Certainly, this is true if:

- the structure is not seen as a sequential order of *turns of moves* of one F, in response to one R, in response to an Initiation from the teacher; rather a sequential order of *kinds of moves* starting from Initiation and ending with Follow-up. From I to F then, the pattern can consist of repeated sub-patterns of I-R, R-F and/or I-R-F.
- the third move is not restricted to evaluation, but open to any kind of follow-up from the teacher that can be categorised in whatsoever labels.
- the second move is not expected, only as a response to ‘already-known answer’ initiations, but also a response to open-ended questions, for which the teacher does not know the answer.

With such articulation of the I-R-F exchange structure, the moves and their pattern can be used as indicators of the form of the talk, as they constitute it in the first place. Table 9.3 offers general description of those differences, but the analysis chapters provide more details through the discussion of the exemplified excerpts of talk.

Indeed those chapters offer more fine details on CT Dialogicity that can raise the discussion of other issues, of the roles of teachers and pupils in different forms of talk, and the influence of the pupils and contextual factors in shifting the form of the talk, for example. The space limitation, however, does not allow for more discussion on such issues, as the rest of the chapter focuses on the aspect of pupils’ learning. Nevertheless, the approach in which this study is tackling the learning issue is of link to CT Dialogicity, as the analysis has illustrated. The next section discusses pupils’ learning in relation to CT Dialogicity.

9.2 CT Dialogicity in relation to learning: how sharp is the difference between Authoritative and Dialogic?

In investigating the relationship between the quality of talk and learning, the study has looked into learning as a *process* and as a *product* in connection to CT Dialogicity, following the adopted definition of learning (refer to section 2.1.3) and reflected, respectively, in the second assumption set to defining the position of CT in relation to teaching and learning, stating that:

- *Learning, as a process, will be influenced by CT as an act of teaching, whether to be*

supported or not. Knowledge appearing to be produced by this process is to be seen as a product, highly 'accomplished' by CT as an act of teaching.

In performing this investigation, the study implemented the approach summarised by fig.9.6. Learning as a process has been examined by looking into the CT characterisation for general indicators of supporting/not supporting learning. In investigating learning as a product, the focus was on the content of the talk, whether in the classroom or in the focus group discussions, to get to the pupils' conceptual understanding. Section 10.1 in the next chapter provides a summary of the results on both routes as presented in the analysis chapters. In this section, I reflect on these results as a whole.

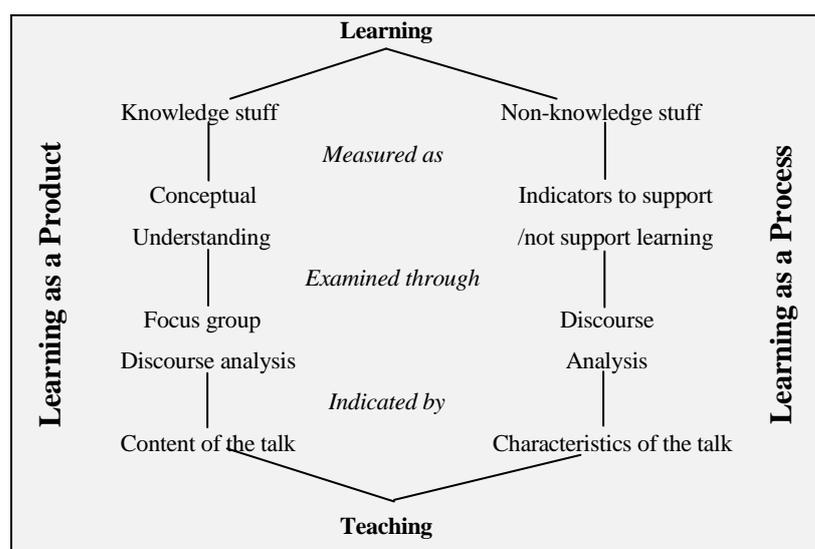


Figure 9.6: The study's approach to investigate pupils' learning

A general interpretation of the results points to the superiority of Dialogic talk in supporting learning over Authoritative talk. However, delving into the details stimulates a slightly different line of argument that brings us back to the question raised in section 9.1.2 concerning the validity of approaching learning as influenced by CT from the discontinuity view. Establishing claims on the significance of one of the two types of talk (certainly, the Dialogic one) over the other (Authoritative one in this case) in regard to supporting learning, seems neither possible nor justifiable, taking primarily into account the following considerations:

1. Authoritative talk is never absent from normal teaching practice, which means that such teaching cannot be of solely Dialogic talk, although the opposite (solely Authoritative) is widely existing.
2. Even in teaching dominated by Authoritative type, the results suggest it is more likely to be of varied levels that exhibit different characteristics; hence a general judgment will discard the peculiarities of levels as well as their intra-relationships.

This means that in looking into the teaching as a whole to examine the contribution of its CT practice to learning, it would not be possible to attribute a finding on learning back to only one definite type of talk. In what follows, I detail this line of argument through the

discussion of the study's results on how CT contributes to the pupils' engagement, intellectual skills and conceptual understanding as representing different lenses of looking at learning as a process and as a product. In doing so, other lateral thoughts are raised due to the unavoidable complexity of investigating learning, most critically in its relation to the teaching practice.

9.2.1 Learning as a process in relation to Authoritative and Dialogic talk characteristics

In the previous section on Dialogicity and teaching, I raised the issue of the 'size' of difference in characteristics between Authoritative and Dialogic types of talk, and showed how this difference get smaller and less distinct as we move from the highest levels towards the border line between the two types (section 9.1.1). Mercer (1995, p. 20) stated that "different kinds of conversational activities offer different ways of engaging with knowledge and developing understanding". It is expected then, that if the lower levels of both types of Authoritative and Dialogic prove to demonstrate similar characteristics, they are likely to have a similar influence on learning. Likewise, the big difference between the higher levels of both types is expected to result in a noticeable difference in how they contribute to learning.

In fact, the results demonstrated a big contrast between Authoritative and Dialogic types in supporting learning as a process, reflected largely by the big contrast in the detailed characteristics (see table 9.1, and refer to sections 6.3.1 & 7.3.2) as well as the frequency, quality, function and pattern of moves that were highlighted in the previous section (table 9.3). The analysis also provided indicators of how high level Authoritative appears to discount pupils' ideas, ignore their personal knowledge and encourage them to memorise information (section 6.3.3.1) whereas Dialogic engages them, values their personal knowledge and encourages them to apply knowledge, analyse and evaluate it (section 7.3.4.1). Nevertheless, the results obtained from case two specifically, demonstrated a number of examples of lower levels of Authoritative talk that seem to have stimulated the pupils to talk through their thoughts, explain their views and develop them towards the desired scientific view (section 8.3.3.1).

Hence, approaching the relationship between CT Dialogicity and learning as a comparison between Authoritative and Dialogic types in relation to their characteristics does not suggest a constant claim because it depends upon which levels of the two types of talk are being compared. Making such a claim is better approached, I argue, in the light of the continuity view within the 'less-more' dialogic model. Even in having teaching showing only Authoritative type of talk of different levels, it is still possible to examine the relationship between conversational activities that vary in their Dialogicity (i.e. different levels of

Authoritative talk) and learning. In line with the continuity view then, this study illustrates that there are advantages of more dialogic talk over less dialogic (i.e. Authoritative of lower levels & Dialogic of higher levels compared to Authoritative of higher levels & Dialogic of lower levels, respectively) because of differences in characteristics²⁵. I view these advantages as opportunities more likely to be offered by more dialogic types of talk. These are:

1. Opportunity to talk and listen

In the lecturing style of teaching, the teacher is a talker and pupils' are listeners. In the more interactive of recitation kind of teaching, the pupils are talkers but they are talking the talk of the teacher; i.e. what the teacher presents and/or wants to hear. More dialogic CT practice is distinctive in offering this opportunity, as the analysis illustrated. Pupils are given the chance to talk, express their ideas to others, and listen, meanwhile, to the other's points of view. This chance to talk about their conceptions, Dawes (2004, p. 678) suggests, is to "provide stimulus to question what is said", describing the pupils' speaking and listening skills as the basis in working with them to develop their understanding. She argued, though, that creating a classroom community of discourse is the function of the teacher. It is indeed that through his/her questions, the teacher can help pupils to "make their meanings clear...consider a variety of views, and...monitor the discussion and their thinking" (Chin, 2006, p.1319). Having this opportunity is about having the chance to engage verbally and intellectually in the talk, and to share control over it. The analysis showed many Dialogic examples and some Authoritative ones from lower level in which the teacher and pupils were engaging in a dialogue, exchanging ideas and sharing control in guiding the talk through their contributions. Being able to express your point of view as well as to reflect on the ideas of others, has been described by Brooks (1999, p. 108) as 'empowering experience' that 'facilitates the meaning-making process'.

2. Opportunity to express and explore understanding

Throughout the chapters of analysis, the results demonstrated how more dialogic talk could stimulate the pupils to express their understanding by being asked for their personal views and existing ideas concerning their everyday as well as their school science experiences. Having the talk opened to their existing understanding, whether reflecting misconceptions, alternative ideas or ones more compatible with the scientific view, has emerged as a significant 'impetus' in motivating and engaging the pupils. Generally speaking, seeking pupils' ideas and points of view, is overwhelmingly recommended in the literature, and always seen as 'good' teaching and 'desired'

²⁵ In evoking these results through the displayed opportunities, I do not make a reference to certain sections in the analysis chapters because such general results are frequently presented in different sections.

education. There is even the argument that “teachers who operate without awareness of their students’ points of view often doom students to dull, irrelevant experiences, and even failure” (Brooks, 1999, p. 60). In science, particularly, where everyday experiences differ from scientific explanations, it has been argued that developing or changing the pupils’ conceptions would be difficult if the teacher is unaware of the pupils’ views prior to and throughout the teaching, as everyday experiences and common sense can be misleading in the first place (Keeley, Eberle, & Tugel, 2007; D. Newton, 2002).

3. Opportunity to work on understanding

Having the base of being able to talk and listen, and express personal views, is vital in supporting pupils’ learning. It has been argued, however, that it is not enough to identify the pupils’ views (as happens in low Dialogic, for example), as teachers need to work with the pupils’ ideas and design opportunities for them to work on their understanding (Keeley et al., 2007). More dialogic talk appeared to open the opportunity for the pupils to work on their understanding, and for the teacher to support this understanding. In defining ‘working on understanding’, Barnes (2008) wrote: “Working on understanding is, in essence, the reshaping of old knowledge in the light of new ways of seeing things” (p.4). The openness of more dialogic talk to pupils’ personal views contributed to revealing their existing understanding, but it is in the course of asking questions of higher cognitive levels through the initiation and elaborative follow-up moves (see section 9.2.2) that pupils were encouraged to: think and re-think aloud; predict, put forward assumptions and/or vote for them before they could be tested by experiment; deconstruct their thoughts, analyse them for logic and consistency in justifying scientific facts and organise and develop them towards more scientific view before even being approved and explained by the teacher. In doing so, the pupils were working on their understanding, reinforced by the teacher’s support. Nevertheless, such a task is neither easy nor straightforward. It has been claimed that finding out what pupils think about taught concepts and what they do not, setting and practising ways of stimulating them to question their own ideas as well as those of others, and building on these to get to views more consistent with the scientific explanations is a challenging task for both the teacher and pupils (Dawes, 2004, D. Newton, 2002).

4. Opportunity to develop habits of thought and engage in argument practice

In some literature on learning, we read about how important it is for the pupils to learn and develop the habits of questioning, thinking, debating, and similar intellectual skills:

“Students need to learn to listen carefully to other’s ideas, and weigh the evidence before changing their own ideas. They need to learn not to accept a new idea simply because their peers think it is correct. They need to learn how to examine all the ideas,

including evidence from investigation and other relevant information sources, before accepting an idea or changing a previously held one” (Keeley et al, 2007, p.8)

Pupils are expected to learn and develop such kinds of skills by having the teacher as an example in practising them, and by doing so themselves. Dawes (2004) argued that being able to identify and articulate their thoughts, does not only benefit directly the pupils in their learning, but also indirectly, by developing their skills of reflection in learning how to question their own thoughts and those of others. Similarly, Scott (1998) argues that dialogic discourse encourages the practice of generative thinking and good habits of mind in questioning and reflecting on the social plane, which might support active, analytic individual thought. While talking about the opportunity to work on understanding, I referred to the practices of revealing the pupils’ personal views and developing them towards the scientific one by stimulating thinking. Questioning is an essential way of doing so. More dialogic talk appeared to support the emergence of questions and responses of high quality (see section 9.2.2); open questions of high level asking for the pupils’ thoughts, followed by elaborative questions requiring high cognitive processes in analysing and justifying these thoughts, and pupils’ responses that sometimes manifested the required high cognitive processes. Questions of high cognitive level have been recommended in the literature due to their role in challenging the pupils “to look beyond the apparent, to delve into issues deeply and broadly, and to form their own understandings of events and phenomena” (Brooks, 1999, p.110).

5. Opportunity to value individual differences

In the environment of dialogic practice, every opinion is welcomed, and opposite opinions are questioned and negotiated without being evaluated. In opening the talk to the pupils’ views through the initiation move, we have seen the teacher in case one at stage two specifically, stimulating the pupils to offer views that contradict the presented ones, and inviting the whole class to evaluate the presented contradictory opinions by choosing the one they think is correct or to offer a new opinion if not convinced by those ones. Such a practice is expected to give the pupils as well as the teacher the chance to value individual differences. In fact, a pupil will come to value individual differences, if his/her opinions are valued by the teacher and other pupils, and surely the teacher is the best example for this. Valuing individual differences does not come only from listening to different opinions and accepting them as ‘possible’ views, but comes also from negotiating and challenging each other’s ideas. More dialogic talk appeared to offer both the teacher and the pupils the chance to question the presented

knowledge, analyse what is said, follow the inconsistency or the logic of others' views and evaluate them. Having the chance and the context to realise and value individual differences in ideas and thoughts, has its advantages in supporting learning as it acknowledges the relativity of knowledge; "The acknowledgment that other perspectives exist implies relativity of importance and merit, and cast doubt on some of the many other "truths" we often accept without reflection" (Brooks, 1999, p.61).

It is to be noted that these advantages of more dialogic talk can be articulated in terms of other opportunities, depending primarily on the approach to learning. Regardless of differences in ways of presentation or articulation, there are two main remarks that are worth mentioning in the context of this discussion:

- Firstly, these opportunities are not concerning pupils only, but are meant for teachers also. In other words, these advantages are not looked at as opportunities provided only for the pupils' to help them with their learning, but also as opportunities for the teachers to help them to support their pupils' learning. In the end, pupils' learning is a shared responsibility between teachers and pupils, and supporting learning has to do with supporting both sides to do so;
- Secondly, the 'how' and 'to what extent' these opportunities are to influence learning is, actually, neither definite nor static. On the one hand this relates to how many of these chances do take place in practice. On the other, it is greatly specified by the context in which they are operated.

Following these opportunities to the product of constructed knowledge is indeed a significant measure of 'to what extent' these opportunities appear to influence pupils' learning. The account in the next section pursues this discussion by looking into the learning through the lens of the cognitive level of the teacher's and pupils' contribution to the ongoing CT.

9.2.2 Learning in relation to the cognitive level

Although the cognitive level of questions and responses has been used to characterise the type of talk through the analysis, pointing, accordingly, to learning as a process, the judgment on its quality is based indeed on the content of the talk and can be used, meanwhile, as an indicator of the learning as a product. Generally speaking, educators believe in the influence of the types of questions the teachers ask on pupils' learning. Some research on questioning points to the finding of pupils being engaged in the teaching with lots of questions, and achieving good learning, if these questions are not limited to traditional, factual closed ones (Alexander, 2000; Rojas-Drummond & Mercer,

2003). Earlier research argues, however, that the effects of teachers' questions on pupils' learning is not really well known (Andre, 1979; Cotton, 1998; Dillon, 1982), and that the claims of "the goodness of higher-level questions remain wish-fulfilling myths" (Andre, 1979, p. 280). This study does not follow the effect of the cognitive complexity of questions (low or high) on pupils' learning directly; rather it examines the types of talk in terms of it, and looks into the cognitive complexity of the responses they invite. This section focuses on the cognitive complexity of both questions (without going into the functions of questioning) and responses in relation to the type of talk, and the influence of this relation on pupils' learning.

	Number of Question		Number of Response	
	Low	High	Low	High
Case 1, Stage 1	49 ²⁶	6	71	6
Case 1, Stage 2	7	53	31	37
Case 2, Stage 1	25	12	30	15
Case 2, Stage 2	24	29	34	17

Table 9.4: Sum of the quality of questions and responses in Cases 1 & 2

The overall results of this study prove that Dialogic talk supports the emergence of questions and responses of high cognitive level, whereas Authoritative does not. However, examining these results in greater depth stimulates a slightly different picture. Table 9.4 sums the overall numbers of questions and responses in regard to their quality for both cases at the two stages.

There are several points that can be raised in the light of these results:

1. There is a big difference in numbers related to the quality of questions (49/6 compared to 7/53, case 1) where there is a big difference in characteristics. The practice of case one in stage one was dominated by Authoritative talk, resulting in 49 low to 6 high question. In contrast, the practice in stage two witnessed many incidents of Dialogic talk, resulting in 7 low to 53 high. Such numbers indicate quite clearly the superiority of the Dialogic type in supporting the emergence of questions of high cognitive level and stimulating responses of relatively high cognitive level as well (71/6 – 31/37).
2. There is relatively a small difference in numbers (25/12 – 24/29, case 2) where there is a less obvious difference in characteristics due to practice characterised by lower levels of both Authoritative and Dialogic types such as the practice featuring the second case. As the second stage witnessed more incidents of Dialogic talk, of higher levels specifically, than the ones observed through the first stage, the results from this case still suggest that Dialogic talk invites more questions of higher cognitive level (24/29) than Authoritative

26 (49) is the sum of all the low quality questions that have been categorised through the application of the developed framework to the exemplified excerpts from case1, stage 1, including Authoritative & Dialogic types.

(25/12), but they do indicate, meanwhile, the potential of lower levels of Authoritative talk.

- Picking some selective examples of Authoritative and Dialogic talk of lower levels from the two cases, and looking into the quality, promotes Authoritative talk in favour of Dialogic in supporting learning in relation to the cognitive level- an unanticipated suggestion, given the overall literature theorisation on dialogue and dialogic practice-:

	Question quality		Response quality	
	Low	High	Low	High
Authoritative, Case 1	1	4	2	3
Dialogic, Case 1	2	3	5	1
Authoritative, Case 2	1	3	2	2
Dialogic, Case 2	4	0	7	0

Table 9.5: *Quality of questions & responses in lower levels of A & D talk*

These numbers illustrate that more of the teacher's questions and pupils' responses of high cognitive level could be heard in low-level Authoritative talk than in low-level Dialogic. This can be easily justified in relation to their characteristics. Authoritative talk from a lower level seems sometimes to have more potential in opening the space for pupils' thoughts because of the persistence of the elaborative voice of the teacher that pushes more deeply into the pupils' views, compared to what is allowed for in Dialogic talk of lower level, as it looks only for the pupils' superficial opinions without asking for details (refer to fig.9.1). Although this is not a persistent finding, it directs attention again to the general result of similar expected influence on learning for lower levels of Authoritative and Dialogic types (refer to section 9.2.1).

- Focusing on the quality of the responses between Authoritative and Dialogic types through the results of case one, raises an important point of discussion. For the Authoritative talk dominated by questions of low level, the results point to a constant cognitive correspondence between the teacher's questions and pupils' responses, that more questions of low cognitive level (49/6) have invited more responses of low cognitive level (71/6). For the Dialogic talk dominated by questions of high cognitive level, however, the results do not show a constant cognitive correspondence as the more questions of high cognitive level (7/53) have not necessarily invited responses of high cognitive level (31/37), although they have encouraged more of them.

In putting these details together, there are some general conclusions that can be drawn:

- The first relates to the same point raised before that learning is better approached from the continuity view of Dialogicity, so a general claim of the '*potential of more dialogic CT to invite questions and responses of high cognitive level and the lower potential of less dialogic CT to do so*' can be made. However, restricting this potential to Dialogic type and inhibiting it for the Authoritative one altogether is not supported by the

findings of this study. It is widely reported, generally, that the persistent practice of traditional authoritative teaching is dominated by closed, factual, low level questioning that invites for responses of the same level (e.g. Carlsen, 1991; Dillon, 1982; Hardman, 2008) whereas the questioning in dialogic teaching practice is used to explore and diagnose the pupils' ideas and scaffold their thinking, so are more likely to be open and call for high level of thinking (Chin, 2006, 2007).

2. From the cognitive correspondence standpoint, the finding that more dialogic talk does not call necessarily for responses of high cognitive level, neither undermines the positive influence of such types of talk on learning, nor undermines the significance of high cognitive questions. Teachers' questions are expected to be of high cognitive level through more dialogic talk, but the pupils' responses might manifest the required high cognitive processes and might not. Research has reported this non-correspondence between high level questions and responses (Andre, 1979; Cotton, 1998; Dillon, 1982). In Dillon's words: "Ask a higher-level question, get any-level answer" (p. 549). In explaining this finding, Dillon (1994) argued that because the teachers typically knows the answers, there is less opportunity to stimulate the pupils' and even the teacher's thinking. Such an explanation can be hardly accepted in the context of dialogic practice, because:

- Firstly, so often the teacher does not really know the answers because simply s/he would be asking for the pupils' views whether concerning their everyday experiences or the discussed scientific content.
- Secondly, given the dialogic context, every opinion is worthwhile, remembering also that responses of low cognitive level often reveal pupils' misconceptions and conceptual difficulties.
- Thirdly, even for Authoritative talk of lower levels, it is expected that the teacher would listen to different answers before s/he declares or presents the desired one, and it is utterly nonsensical to expect these answers to always reflect a high level of thinking even for a question seeming to ask for it. In fact, this point of the teacher's questions being usually answered by only one student at a time, has been seen as a problem of research concluding that questions of high level have little demonstrated relationship to pupils' achievement (Andre, 1979).

For more dialogic talk then, the results of this study do confirm the finding of the non-cognitive correspondence between questions and responses regarding the high level, but does prove, meanwhile, a *tendency* of high level questions to call for high level responses, supporting therefore the assumption that the types of questions the teachers ask "can, to some extent, influence the cognitive processes that students engage in as

they grapple with the process of constructing scientific knowledge” (Chin, 2006, p. 816)

3. Following the above, if the findings support a positive relation between more dialogic talk and pupils’ learning as this study does, and that this type of talk supports the emergence of questions and responses of high quality, then it is legitimate to claim that high cognitive questioning featuring more dialogic talk has the potential to support pupils’ learning (fig.9.7), thus reinforcing the claim of those who promote the positive effect of high level questions in general on learning.

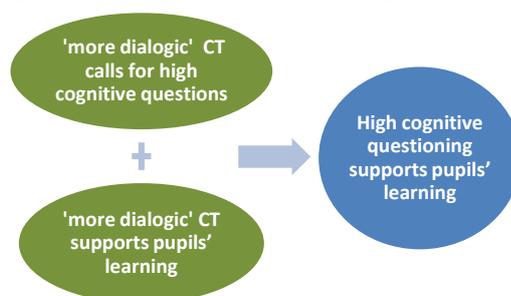


Figure 9.7: Learning in relation to the cognitive complexity

9.2.3 Learning as a product in relation to the resultant ‘shared knowledge’

Comparing the pupils’ performance in the focus group discussions between the two stages raises an interesting point of difference in learning. It relates to the nature of the common knowledge that the participating pupils appear to share in relation to the discussed scientific subject matter. What the pupils might share of prior knowledge and past experiences, and what the teacher and pupils might share as a *learning community* regarding social, cultural and/or historical details of the context of that learning community (Mercer, 2000; Roth & Lee, 2006), are the kinds of common knowledge expected prior to and throughout the teaching. It is likely that pupils’ learning will be determined by such knowledge. However, in looking into learning as a product, the centre of attention is what the pupils appear to share subsequent to the teaching of the taught scientific subject matter as set by the curriculum. Taking Mercer’s (2000) anticipation that the “product of a conversation is usually the achievement of some new, joint, common knowledge” (p.6), with regards to the study’s aim to relate CT Dialogicity to learning, then the following assumption can be made:

Difference(s) in the constituted common knowledge between different teaching practices can be attributed to some extent to difference(s) in the quality of the CT in those practices.

Needless to prove, the nature of the resultant common knowledge that the pupils appear to share subsequent to a teaching context can comprise desired scientific knowledge as well as undesired conceptual difficulties and misconceptions. In the next and last chapter of this report, I summarise the results on the pupils’ understanding in both cases, as compared to each other for each stage (table 10.6 & table 10.7, section 10.1.2). This summary offers the exact

scientific knowledge and conceptual difficulties the participating pupils exhibited as groups. Nevertheless, putting the results of the two cases from both stages altogether, suggests generally the *tendency* of the teaching with more dialogic CT to result in a more solid scientific understanding as compared to the one resulting from teaching with less dialogic talk. In other words, the more the CT is ‘more dialogic’, the higher is the probability that the common knowledge the pupils appear to share will consist of more scientific conceptions and explanations and less misconceptions and conceptual difficulties. I attempt in fig 9.8 to illustrate this tendency by commenting on the nature of the shared knowledge following from a certain teaching context in relation to the demonstrated quality of the practised CT in that context, at least as indicated by the analysis performed in this study.

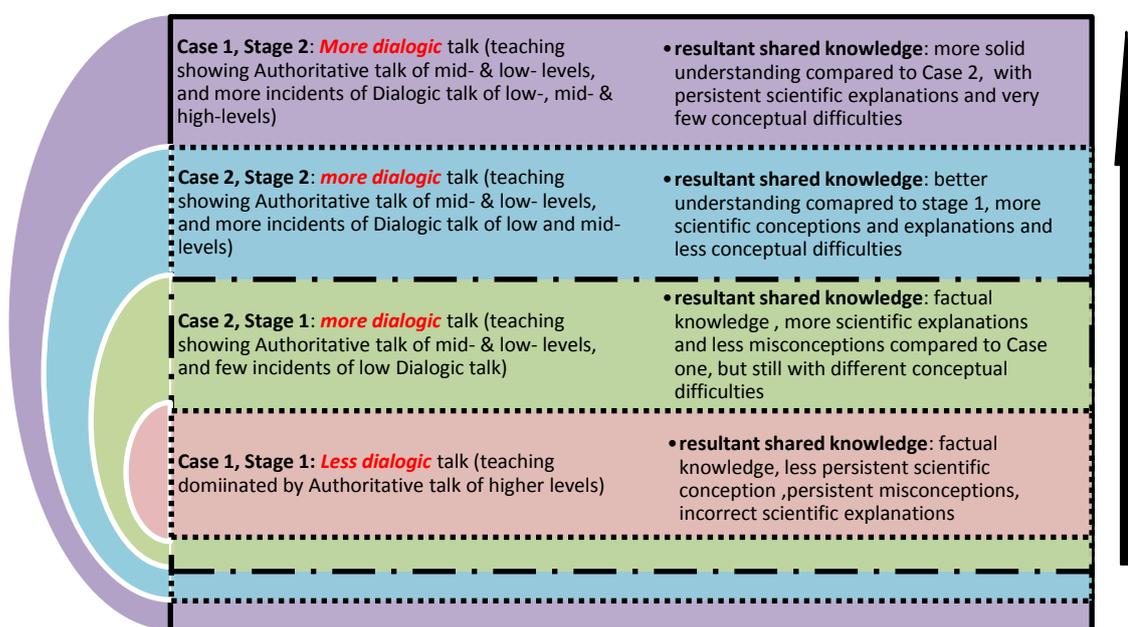


Figure 9.8: CT Dialogicity in relation to the common knowledge following from the teaching

To explain this tendency, let us recall a summary of the results of the pupils’ conceptual understanding in case one between the two stages. In stage one dominated by high level Authoritative talk in teaching the ‘substance changes’ topic, the pupils appeared to share some factual knowledge related to the general definitions of physical and chemical changes and evidence of chemical change, in addition to other scientific conceptions that go beyond the factual knowledge such as perceiving change of colour as not necessarily pointing to a sign of chemical change. Meanwhile, they appeared not to share different scientific views considered significant to having a good understanding of the topic²⁷, some of which are:

- Physical/chemical (P/C) features are different from P/C changes;
- Chemical change does change the external features;
- Formation/non-formation of a new substance is the main criteria in differentiating

²⁷ As pointed out in chapter 6 (section 6.4) these views have not been discussed explicitly through the teaching that was dominated by Authoritative talk. More on the relation between teaching & learning is in section 9.3.

between P/C changes;

- There is no new substance resulting from physical change that needs to be reversed;
- Signs of change in colour/temperature and formation of gas/precipitate are considered evidence of chemical change only if they indicate the formation of a new substance.

In fact, the absence of these views was reflected in the many conceptual difficulties that all or some of the participating pupils appeared to hold, and which led eventually to the pupils giving incorrect judgments on whether some changes were physical or chemical, as well as offering mistaken justifications that revealed a ‘fragile’ understanding of the topic overall. Even for those who were presenting views more compatible with the scientific ones, they appeared not very convincing sometimes and were not able to defend their views strongly (refer to section 6.4).

Following the teaching of the more difficult topic of ‘electric circuit’ during stage two that witnessed many incidents of Dialogic talk of the mid and higher levels and Authoritative of lower level generally, the results demonstrated overall a very good understanding of the topic. The results have not proved various documented misconceptions like the charges originating in the battery and not in the wires, and the bulb consuming the charges and not the energy, for example (Brna, 1988; Engelhardt & Beichner, 2004; Tsai, Chen, Chou, & Lain, 2009). Quite the opposite, scientific conceptions like the wire as the source of charges, the battery as the source of energy, the bulb as transferring energy to light and heat, were frequently used by the pupils in their argument on different points of discussion. This gave the impression of such important scientific conceptions being regarded as axiomatic and unquestionable in understanding the working of electric circuit. The analysis illustrated also a solid understanding of more difficult scientific explanations related to the simultaneous movement of the charges and their conservation, the instant lighting of the bulbs, and the constant intensity of the current, for example. Such scientific conceptions and explanations, in addition to the general factual knowledge concerning the topic, have all constituted ‘common knowledge’ that the participating pupils agreed on and shared. Nevertheless, some conceptual difficulties appeared to be shared by some pupils, and which could be traced back to difficulties in understanding the basic entity of energy, and how it is transferred in the circuit (refer to section 7.4).

What is more, one of the insights that the analysis of focus group discussions has demonstrated proves that the pupils who shared the same teaching and classroom interaction experiences, did not appear to necessarily share the same knowledge. In the two stages overall, some among the five interviewed pupils showed a more solid understanding than others, some seemed more confused and some more convincing in defending the scientific views than others. Indeed, this is an outcome expected from any teaching practice.

However, the results suggest that individual differences²⁸ in understanding were more evident following the teaching of the first stage than of the second stage. In other words, when the teaching was of less dialogic CT, the gap in understanding between individual pupils was more persistent than in the teaching practice of more dialogic talk (refer to sections 6.4 & 7.4). One of the explanations for this difference can be linked to the nature of the pupils' shared knowledge. To clarify, it can be argued that the common knowledge the pupils appeared to share following the practice of more dialogic talk- of many scientific conceptions and explanations- might explain the little gap in understanding between the interviewed pupils. This means that because the pupils in the second stage had a solid understanding of the taught topic, they appeared to agree over explanations of the questioned content more than they disagreed. This might suggest then that the more solid the understanding that is developed by a group of pupils, the less is the gap in understanding between them as individuals.

Opening this discussion about individual differences brings us back to the argument over the views of learning as social and individual (refer to section 2.1.3). Barnes (2008) wrote that the term of common knowledge initiated by Edwards and Mercer (1987) "reminds us that the construction of knowledge is essentially a social process" (p.8). However, the differences in the common knowledge between groups of pupils sharing relatively the same teaching context reinforces our thinking of the construction of knowledge as essentially a cognitive process. What I want to stress in regard to this is that such differences were less likely to be captured if the approach of the analysis was not taking the individual's learning into consideration in its operation of the tools of research and method of analysis. Basically, if learning is to be measured in terms of the common knowledge that the pupils develop, given that this knowledge comprises desired scientific conceptions as well as undesired misconceptions, then the individual perspective must be employed. In other words, data on individual understanding are needed to ascertain what knowledge/understanding is shared and what is not.

The next section continues in discussing results on pupils' learning by commenting on the study's attempt to follow these results back to the teaching to examine the relationship between CT Dialogicity and learning.

9.3 Learning does not stand in isolation from teaching

It is quite clear that the second assumption does not look at the relationship between CT and

²⁸ Individual differences here does not refer necessarily to one individual holding a view different from another individual. It mainly refers to a group of individuals (e.g. 2) disagreeing with another group; the one mostly noticed in this study. In this sense, what is considered as common knowledge is relative to the group in discussion.

learning in isolation from teaching, as it perceives CT as an act of teaching in the first place. (refer to section 9.2). Certainly, learning is not a destination but a journey, as Brooks (1999, p.67) expresses it. However, as referred to before quoting Ausubel (1968), facilitation of learning is the only proper end of teaching (section 2.1.2). Investigating pupils' learning in a certain context then, needs to go back in time to examine the teaching that took place in that context, even if just passing the second(s) between a pupil's response and the teacher's question that the response answers, because basically "as a conversation progresses, the content of what is said provides a contextual foundation for the talk which follows" (Mercer, 2000, p. 44). Mercer (1995) suggested that the failures in the process of sharing knowledge and developing understanding "maybe better understood by looking carefully at the talk that generates them" (p.2), building such suggestions on the argument that the educational process is better be described as an interactive process of 'teaching-and-learning' rather than being separate processes of 'teaching' and 'learning' (Rojas-Drummond & Mercer, 2003, p. 100).

The aim of this study in characterising CT Dialogicity in relation to pupils' learning is following this line of thought. Basically, the design of the study in carrying out a TI is built on the assumption that changing the teaching practice (by changing the quality of CT) will influence pupils' learning. The results have continually supported this assumption by demonstrating several advantages of teaching with more dialogic CT in supporting pupils' learning.

Moreover, following the pupils' understanding back to the teaching to examine how certain concepts or ideas have been handled through the discursive practice has further reinforced this assumption by offering different indicators. Although these indicators cannot be organised within a certain pattern, as more results from more researched cases are still needed, these indicators from both cases at both stages are consistent in confirming that the conceptual understanding that the pupils demonstrated is highly influenced by what happened in the classroom. From case one, the results indicate that:

- wherever the teaching presented incorrectly/imprecisely certain conception (s), the pupils appeared to experience conceptual difficulties or uncertainty in understanding that (those) conception(s), which led eventually to some of them giving incorrect answers/judgments. Within Authoritative practice, the teacher could not become aware of the confusion the pupils experienced through her imprecise presentation of scientific information;
- the pupils appeared to have different conceptual difficulties with the issues that have not been detailed whether through Authoritative or Dialogic CT, which led eventually to some of them giving incorrect answers/judgments;

- the teaching practice dominated by Authoritative talk resulted in many conceptual difficulties in understanding the subject knowledge presented through it;
- when there was Dialogic talk from different levels exploring in detail a certain issue/point, followed by Authoritative talk confirming and explaining the scientific view, the pupils appeared to have not only a correct conception, but rather a solid and persistent understanding of that issue/point;
- when a certain issue/point was initiated through Dialogic talk, but not discussed in more detail through Dialogic talk of higher level and its scientific explanation has not been stated or explained through Authoritative talk, the pupils appeared to have an incorrect conception or uncertainty about it;
- when attention was paid to 'less difficult' issues through Authoritative talk, the pupils appeared to have a good understanding about them;
- when no attention was paid to certain misconceptions related to 'more difficult' scientific issues through Dialogic and Authoritative talk, the pupils appeared to experience conceptual difficulty or uncertainty in understanding.

The results from case two proved some of the above assertions, demonstrating, specifically, the negative influence of the absence of the Dialogic talk of higher level from the teaching practice, as well as the positive influence of the Authoritative talk of lower level. It suggested also that the kinds of activities the teacher used, and the Authoritative as well as Dialogic talk have not contributed to supporting pupils' learning because of those activities' ambiguity and unsuitability. Such results reinforce again Mercer's suggestion of describing educational practice as 'teaching-and-learning', supporting, accordingly, the significance of taking the sociocultural perspective in doing so, bearing in mind though that operating the individual view empirically within this perspective is absolutely essential (refer to sections 2.1.3 & 10.2.1). Furthermore, these results prove that the development of rich, domain-specific conceptual knowledge is influenced by the quality of CT in relation to its type and level as well as the shift between them:

- Both Authoritative and Dialogic types are needed;
- It is not just about the different types of talk being practised in a certain incident- it is about the level of the type of talk, the relevance and clarity of the subject of the talk, and the success in shifting between types and levels of types of talk;
- If the Dialogic talk is to have its ultimate positive influence on learning, it has to be of higher level. Dialogic talk of lower level is needed, but it is not enough. Understanding is facilitated by the conceptions being debated through higher level of Dialogic talk;
- The needed Authoritative talk takes a part in the construction of knowledge in addition to supporting this construction following Dialogic talk. This is different from the

Authoritative talk being used to transmit knowledge.

These insights resonate with what Mortimer, Scott and their colleagues have established of the necessity of the shift between the different classes of the CA to support a meaningful learning (Scott et al., 2007; Scott & Ametller, 2007; Scott et al., 2006). They also support what the investigation of ‘dialogic teaching’ has led to, emphasising the need of the teaching to be dialogic, to develop in continuous thematic lines, and to involve:

- Introducing ideas in a logical sequence to create a continuous thematic line, consequent upon reviewing and revisiting ideas,
 - Enabling students to apply new ideas in a range of contexts,
 - Enabling student reflection on personal understanding,
 - Consequent upon the teacher monitoring and being responsive to student thinking.
- (Scott et al., 2007, pp. 19-20)

What is different about this study in regard to these insights is that they have been drawn as conclusions from following the results of pupils’ understanding back to the teaching. These insights suggest that wherever the teaching seems to have supported the learning of certain conceptions as indicated by the CT, the pupils appeared to have a rather good understanding of those conceptions. In contrast, the pupils showed conceptual difficulties with those conceptions that the teaching seems to have failed to support through the CT.

This suggests, in turn, that investigating the pupils’ developing understanding to answer questions about learning is less likely to offer trustworthy insights, if the teaching that the pupils experienced has not been included. A more general insight that can be made from this is that teaching cannot be judged in isolation from pupils’ learning, neither pupils’ learning can be judged in isolation from the teaching that occurred.

9.4 Summary

In this chapter, the outcomes of the study have been discussed in relation to the main research aims of: a) characterising CT Dialogicity, and b) investigating its relation to pupils’ learning. In the first part concerning CT Dialogicity in relation to teaching:

- A multi-level (A-D) model has been suggested as a development of the CA to be implemented to characterise CT Dialogicity empirically;
- The model of ‘less-more’ dialogic has been argued to provide a flexible and broad theorisation of CT Dialogicity;
- It has been argued that various other labels used in literature to describe the nature of CT can be approached from the Dialogicity perspective within the theoretical model of ‘less-more’ dialogic;
- It has been argued that the I-R-F structure- used in literature to describe the nature of

CT- has the potential to attend to types of CT different in their Dialogicity, if being considered as a sequential order of *kinds of moves*, rather than *turns of moves*.

In the second part concerning pupils' learning in connection to CT Dialogicity; it has been suggested that the relationship between the two is better approached from the Dialogicity continuity perspective, asserting the following:

- There are advantages of more dialogic talk over less dialogic in supporting pupils' learning because of the difference in characteristics between the two;
- More dialogic CT has the potential over less dialogic to invite questions and responses of high cognitive level;
- The more the CT is 'more dialogic', the higher is the probability that the common knowledge the pupils appear to share will consist of more scientific conceptions and explanations and less misconceptions and conceptual difficulties;
- The more the CT is 'more dialogic', the less persistent is the gap in understanding between individual pupils, suggesting accordingly that the more solid an understanding is developed, the less is the gap in understanding between pupils.

The third summarised the relationship between the three; CT Dialogicity, teaching and learning;

- Learning is connected to the CT characterisation from the Dialogicity perspective;
- Learning does not stand in isolation from teaching.

The next chapter concludes this report by offering the summary, implications and limitations of the study.

10 CHAPTER 10: SUMMARY AND IMPLICATIONS

This study raises a wide range of issues concerning CT Dialogicity and how it characterises teaching and contributes to pupils' learning. They are the product of an interactive discussion between theoretical informed ideas and empirical data and results. In this final chapter, I offer a summary of the study's main results and findings in relation to the research questions (section 10.1) to give the reader an overview of all the detailed accounts presented in the previous chapters. Most importantly, the next section addresses the contribution of this study and its implications for research and teacher training (10.2). This is followed by considering the main sources of the study's limitations (10.3), to end with some final thoughts (10.4).

10.1 Summary of findings in relation to research questions

The study has witnessed a gradual shift in its concern from examining Omani science classes for the extent to which dialogic CT is practised, to be focusing on the theoretical issue of CT Dialogicity, integrating a critical review of existing literature and empirical characterisation of CT data from Omani science classes. Dialogicity; as a perspective through which the nature of CT is described, has been framed throughout this study in relation to teaching and learning. Its characterisation within this frame constituted, in fact, the main purpose of the study (refer to section 1.2). Accordingly, two main aims have been set, each consisting of three research questions (refer to section 5.1). Answering directly these questions has been divided between the analysis and discussion (refers to the synthesis of ideas in chapter 9) chapters, as represented in fig.10.1.

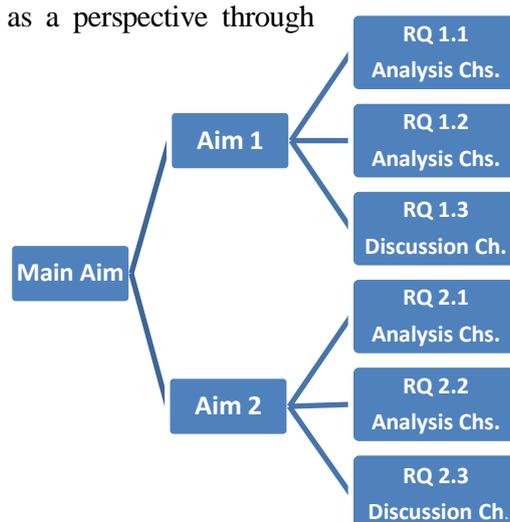


Figure 10.1: Research questions within the structure of the thesis

There follows a summary of the results and findings in relation to each research question:

10.1.1 Aim 1: Characterising CT from the Dialogicity perspective in relation to the Authoritative-Dialogic classification of talk

1.1. What classes of communicative approach does the recorded CT exhibit?

The results on the CA classes obtained from the surface analysis (section 5.8.1) have been presented in the second section of each analysis chapter (i.e. 6.2, 7.2 & 8.2). Tables 10.1 and 10.2 summarise the results of cases one and two, respectively.

Class of talk, C1	Interactive / Authoritative (I/A)		Non-interactive / Authoritative (NI/A)		Interactive / Dialogic (I/D)		Non-interactive / Dialogic (NI/D)	
	1 st Stage	2 nd Stage	1 st Stage	2 nd Stage	1 st Stage	2 nd Stage	1 st Stage	2 nd Stage
Lesson 1	69 %	68 %	31 %	32 %	0 %	0 %	0 %	0 %
Lesson 2	66 %	35 %	27 %	25 %	7 %	33 %	0 %	7 %
Lesson 3	68 %	8 %	32 %	2 %	0 %	74 %	0 %	16 %
Lesson 4	76 %	28 %	24 %	29 %	0 %	40 %	0 %	3 %
Lesson 5	62 %	53 %	38 %	47 %	0 %	0 %	0 %	0 %

Table 10.1: Percentages of categorised CA classes of talk, C1: S 1 & 2

Class of talk, C2	Interactive / Authoritative (I/A)		Non-interactive / Authoritative (NI/A)		Interactive / Dialogic (I/D)		Non-interactive / Dialogic (NI/D)	
	1 st Stage	2 nd Stage	1 st Stage	2 nd Stage	1 st Stage	2 nd Stage	1 st Stage	2 nd Stage
Lesson 1	58 %	32 %	36 %	10 %	6 %	46 %	0 %	12 %
Lesson 2	88 %	31 %	11 %	26 %	1 %	37 %	0 %	6 %
Lesson 3	62 %	49 %	24 %	23 %	14 %	17 %	0 %	11 %
Lesson 4	52 %	47 %	41 %	19 %	7 %	32 %	0 %	2 %
Lesson 5	55 %	49 %	32 %	26 %	13 %	23 %	0 %	2 %

Table 10.2: Percentages of categorised CA classes of talk, C2: S 1 & 2

Overall, the results demonstrated a noticeable change in the practices of the two cases between the two stages, with more and varied examples of Dialogic talk in the second stage after the intervention.

1.2. What features of Authoritative and Dialogic communicative approaches, are revealed by the implementation of the analytical framework?

All of the issues raised in the synoptic analysis section in the analysis chapters (i.e. 6.3, 7.3, 8.3 & 8.5) offer some findings in addressing this question. Here is an account of the main issues through which the two types of talk have been characterised, with a brief summary of their findings:

1. What has constituted the Authoritative/Dialogic talk?

The analysis using the framework revealed some general characteristics of the Authoritative (section 6.3.1) and Dialogic (section 7.3.2) types that have been noticed repeatedly. However, differences in these characteristics were captured between the examples of each type. In some examples, all of the general characteristics seem to feature in the talk while in others some of them disappear completely or look less evident. This main attribute of difference is what I used to label each type into different levels of high-, mid- and low-Authoritative (fig.6.2) or Dialogic (fig.7.2). This is not a place to re-display the figures of levels. Rather I provide fig.10.3 that summarises the main characteristics of each type in its high and low levels, to demonstrate how the multi-levelness allows the comparison between the two types to be approached via different routes (the following comparisons can be

made; (High A-High D or Low A-Low D); (High A-Low A or High D-Low D) or (High A-Low D or High D-Low A)).

	Authoritative Talk	Dialogic talk
High Level	<ol style="list-style-type: none"> 1. Dominance of the evaluative voice of the teacher 2. Movement of the talk towards very-defined scientific view 3. Absence of the neutral/challenging voice of the teacher 4. The teacher controls the talk strongly and persistently 	<ol style="list-style-type: none"> 1. Absence of the evaluative voice of the teacher, substituted with a neutral one 2. Openness of the talk to the pupils' profound ideas 3. Persistence of the elaborative voice of the teacher 4. The teacher shares with the pupils the control over the talk
Low Level	<ol style="list-style-type: none"> 1. Absence of the evaluative voice until the very end of the talk 2. Movement towards the scientific view at the very end of the talk 3. Emergence of the teacher's neutral & elaborative (not challenging) voice 4. Pupils share control by presenting more in-detail views 	<ol style="list-style-type: none"> 1. Absence of the evaluative voice of the teacher, substituted with a neutral one 2. Openness of the talk to the pupils' superficial ideas 3. Persistence of neutral voice, and nearly absence of the elaborative voice. 4. Pupils share control over the talk by presenting general views

10.3: Comparison between High & Low levels of A and D talk

2. How has the teacher reduced her control over the talk?

This issue has been discussed in different contexts for both cases. In case one at stage two, the teacher's attempt to practise Dialogic talk without succeeding to do so in the first lesson has initiated this issue of looking into the strategies she was using to reduce her control over the talk (first block in table 10.4, with more details in section 7.3.1) after going through the TI.

Case 1 Stage 2	<ol style="list-style-type: none"> 1. Setting the purpose of the talk as exploring pupils' views 2. Setting the content to include personal views and to relate to everyday experience 3. Listening to the pupils' incorrect views without disapproving of them 4. Elaborating the pupil's presented views 5. Inviting for different or multiple opinions 6. Asking questions of high cognitive level
Case 2 Stage 1	<ol style="list-style-type: none"> 1. Asking for the pupils' opinions and ideas <ul style="list-style-type: none"> • setting the content to relate to the everyday experience of the pupils; • asking for the pupils personal view in relation to everyday content, theoretical scientific content, empirical scientific content and in relating empirical to theoretical content; • asking for different personal views; • asking the pupils to ask. 2. Listening to the pupils' opinions and ideas <ul style="list-style-type: none"> • Praising the pupils' contributions without evaluating them and opening the talk for other opinions; • Commenting on the offered responses, accepting them, elaborating them for more clarification; and asking for more contributions; • Responding to the pupils who ask to present their opinions by giving them the chance to do so; • Even when evaluating a pupil' response, she was leaving a space for the pupil to contribute to the talk more, if wanted to.

Table 10.4: How has the teacher reduced her control over the talk, C1, S2 & C2, S1

In case two at stage one, the teacher's practice was already demonstrating Dialogic CT, certainly without the teacher being aware of such classification of talk. Accordingly, I focused in coding the results on the key attributes that seem to have caused such dialogic practice (second block in table 10.4, with more details in section 8.3.1). A similar issue was opened in discussing this teacher's practice in the second stage, focusing on how she has managed the transition towards more Dialogic talk. It followed a different procedure by paying attention to how the teacher guided the Dialogic talk into the different levels of low, mid and high (refer to section 8.5.1).

3. What has influenced the level of the Authoritative/Dialogic talk?

The different contexts in both cases and between the different stages have also influenced how this issue was followed and discussed. This was largely specified by the kind of data available and how much it offers on the issue. Nevertheless, I focused the analysis on following the influence of the pupils and contextual factors (refer to sections 6.3.2.2, 7.3.3.2 & 8.3.2). Here is a summary of the main findings on this issue from the two cases:

Pupils' influence

In the first stage, the pupils in case one appeared to support the high authority of the teacher by trying to recite what she wanted to hear regardless of their thinking, and by not questioning what was presented. They did not influence the exchanged talk in a way that led it in a direction different from the one set by the teacher or that could lessen the authoritative level imposed by her practice (see section 6.3.2.2). By way of contrast, the pupils in the second case appeared to influence the talk through their questions and the level of their responses. Overall, their influence has been coded into three effects of (see section (8.3.2.1):

- Reducing the level of the Authoritative talk
- Influencing the talk to shift from Authoritative to Dialogic
- Influencing the talk to shift from Dialogic to Authoritative

In the second stage, the pupils in case two appeared to influence the talk in a similar way to what has been noticed in stage one. Through their frequent questions, they continued to reduce the control of the teacher. They also responded to the teacher's attempt to practise more Dialogic talk by presenting their ideas and negotiating them. However, Dialogic talk of higher level was less frequent, and the pupils did not appear to influence the talk towards such level as there was no interaction between each other's ideas. Pupils in case one were again responding to the teacher's way in guiding the talk, but supporting dialogic practice this time. This appeared through their readiness to offer their opinions and to express their agreement or disagreement of the presented views without always being asked directly to do so. They, themselves, illustrated a dialogic practice in listening to each others' opinions and

enriching the talk with more and thorough ideas. In disapproving of some of the conventional views and presenting unusual ones, moreover, the pupils were contributing to identifying the dialogic level of the talk to be of challenging these unusual views (7.3.3.2).

It is quite remarkable actually how the pupils' participation, engagement and share of control in case one, particularly, has changed radically between the two stages, in response to the change in the teaching practice. Certainly, this has implications for teacher training towards more dialogic practice and on research on dialogic teaching (see section 10.2.3).

Contextual factors' influence

The type of the talk and its level appeared to be influenced by contextual factors. The captured influence from the different analysis chapters can be summarised into three effects:

- Reducing the Authoritative level of the talk
- Supporting the emergence of Dialogic talk
- Influencing the Dialogic talk to be of certain level

This influence has been related to the interaction between the contextual factors of the purpose and the content of the talk in addition to the teaching intervention. Basically however, both the purpose and the teaching intervention are inferred in this study from the content of the talk. Examining the influence in this section was built accordingly around the nature of the content. Here is an overview of how the type and level of talk appeared to be influenced by the content:

- Everyday/scientific;
 - Expectedly, everyday content as relating to everyday experiences has driven the talk to be of lower level of Authoritative (section 6.3.2.2) or to be Dialogic (section 8.3.2.2).
- Theoretical/empirical:
 - The 'empirical' content has been used to lower the control of the teacher over the talk due to its relation to the students' own work and observations (section 6.3.2.2)
 - In stage two, the empirical content has been used to challenge the pupils' views, influencing the type of Dialogic talk to be of higher level (section 7.3.3.2).
- Easy or difficult, simple or complicated:
 - In the first stage, simple and less difficult scientific content, whether theoretical or empirical, appear to support, most frequently, Authoritative talk of higher level (section 6.3.3.2).
 - In the second stage when the teachers were attempting more dialogic practice, more difficult and complicated scientific subject matter appeared to stimulate Dialogic talk of higher level (section 7.3.3.2)

In fact, the broadness of this aim of investigating the features of Authoritative and Dialogic types allowed the analysis to go into the different directions identified by the three issues explained above. Although the last two issues could not be reflected on and discussed as the first one, their details provided in the analysis chapters direct attention to different thematic points that can be further explored in research.

1.3 Reflecting on the outcomes of 1.1 & 1.2, how can CT Dialogicity be conceptualised both theoretically and empirically, in relation to the existing relevant literature?

In discussing the findings from the empirical study in view of the relevant literature, two models to characterise the nature of CT from the Dialogicity perspective have been suggested. The first comes as a development of the Authoritative-Dialogic model offered by the CA to examine CT Dialogicity empirically, towards a multi-level one. This multi-level model offers a more detailed scheme of CT Dialogicity, according to which each type of Authoritative and Dialogic is seen as a continuum of descendant/ascendant features. This has resulted in viewing each type of talk along three general levels of high, mid and low (refer to section 9.1.1). Deeper reflection on this model led to propose the ‘less-more’ dialogic model to approach CT Dialogicity at the theoretical level. This model stands as a flexible and open description of the nature of some CT in comparison to what appears as a different type of CT. Accordingly I suggested that this model can be used as a reference for empirical model(s), due to the relative and open meaning of CT Dialogicity it offers, and its approximation of the relationships between the types of talk in comparison (refer to section 9.1.2).

10.1.2 Aim 2: Investigating the relationship between the characterised Dialogicity of CT and pupils' learning

2.1 What indicators of the potential of Authoritative and Dialogic communicative approaches to support pupils' learning, are revealed by the implementation of the analytical framework?

This question has been addressed directly in the last subsection of the synoptic analysis (i.e. 6.3.3, 7.3.4, 8.3.3 & 8.5.2), of:

- How does the Authoritative/Dialogic talk seem to support/not support pupils' learning?

This issue has been tackled through three indicators of pupils' engagement, the cognitive level of questions and responses, and the pupils' developing understanding. Overall, the results reinforce the potential of Dialogic talk to support pupils' learning more than Authoritative talk. As pointed out through the summary of RQ 1 however, there are different levels within each type. The lower levels from both types appeared to share features more than they vary. Accordingly, low level of Authoritative talk showed advantages in supporting learning similar to those that featured in Dialogic talk in general. Table 10.5 summarises the main results noticed between the higher levels of both types.

	Authoritative, high level	Dialogic, high level
Pupils' engagement	<ul style="list-style-type: none"> - poor engagement - limited chances to participate - short pupils' responses - frequent group answers - neglect of pupils' views and ideas 	<ul style="list-style-type: none"> - high engagement - frequent chances to participate - extended pupils' responses - group answers to vote for different views - talk is guided by the pupils' views - reinforce the pupils' motivation and argumentative skills
Cognitive level of Q & R	<ul style="list-style-type: none"> - dominated by low quality questions and responses 	<ul style="list-style-type: none"> - frequent high quality questions - potential to invite high quality responses
Pupils' developing understanding	<ul style="list-style-type: none"> - cannot be followed because the analysed CT does not reveal the pupils' thoughts 	<ul style="list-style-type: none"> - reveal pupils' mis/ alternative conceptions - challenge the pupils thoughts - influence the pupils to develop their mistaken views towards more scientific ones - enrich & develop the pupils' understanding

Table 10.5: Indicators on the potential of A and D talk to support pupils' learning

2.2 What evidence is there of pupils' conceptual understanding following the observed teaching?

This question has been addressed in the last section of each analysis chapter (i.e. 6.4, 7.4, 8.4 & 8.6) by presenting the results from the focus group discussion, supported by the pupils' writings in the bubble dialogue sheets, and tracing the results back to the teaching. The structure of this section was specified by the subject knowledge of the scientific topic taught in each stage; 'substance changes' in 1st stage, and 'electric circuit' in 2nd stage.

In stage one, the pupils in case two showed generally a more solid understanding and less misconceptions than the pupils in case one, although they still appeared to face some difficulties. The results also illustrated a resonance between the pupils' conceptual understanding and difficulties and what happened in teaching. Table 10.6 summarises the results on the pupils' understanding in stage one between the two cases.

It was the opposite in stage two. The pupils in case one are those who showed the more solid understanding and less misconceptions as compared to the pupils in case one, although they still appeared to face some difficulties. Again, the resonance between the pupils' conceptual understanding and difficulties and what happened in teaching could be spotted in this stage. Table 10.7 summarises the results on the pupils' conceptual understanding in stage two between the two cases.

Stage 1 'Substance Changes'	Case 1	Case 2
Change of external/ internal features	<ul style="list-style-type: none"> - raised but not applied to judge the type of change - big confusion when discussed <p>Misconceptions/difficulties:</p> <ul style="list-style-type: none"> - what are internal features and how they change is not recognised - mix up substance features with change characteristics - chemical change changing internal & external features is not recognised <p>Back to teaching:</p> <ul style="list-style-type: none"> - mix up substance features with change characteristics - no explicit discussion of the details of the internal and external features and how are changing 	<ul style="list-style-type: none"> - frequently applied to judge the type of change, incorrectly sometimes - understanding is not solid/consistent <p>Misconceptions/difficulties:</p> <ul style="list-style-type: none"> - what are internal features and how they change is not recognised - mix up substance features with change characteristics - chemical change changing internal & external features is not recognised <p>Back to teaching:</p> <ul style="list-style-type: none"> - mix up substance features with change characteristics - no explicit discussion of the details of the internal and external features and how are changing
Formation/ non- formation of new substance	<ul style="list-style-type: none"> - raised but rarely applied to judge the type of change <p>Misconceptions/difficulties:</p> <ul style="list-style-type: none"> - its connection to other characteristics and evidence of chemical change (CC) is not evident <p>Back to teaching:</p> <ul style="list-style-type: none"> - not clearly & explicitly connected to other characteristics - rarely applied to judge the change - not connected with evidence of CC 	<ul style="list-style-type: none"> - frequently applied to judge the type of change, correctly and confidently - successfully connected to other characteristics. <p>Difficulties:</p> <ul style="list-style-type: none"> - not applied when confused about the evidence of chemical change (CC) <p>Back to teaching:</p> <ul style="list-style-type: none"> - clearly connected to other characteristics - not connected with evidence of CC
Reversibility/ Irreversibility	<ul style="list-style-type: none"> - vastly applied to judge the type of change - confused application resulting in incorrect judgment is evident <p>Misconceptions/difficulties:</p> <ul style="list-style-type: none"> - confusion about getting the substance back to its initial external shape - absences of the possibility point from the pupils' awareness <p>Back to teaching:</p> <ul style="list-style-type: none"> - haziness in specifying the meaning of the ir/reversibility - no explicit discussion of the reversibility meaning - not clearly connected to other characteristics 	<ul style="list-style-type: none"> - frequently applied to judge the type of change, correctly and confidently - successfully connected to the other characteristics. <p>Back to teaching:</p> <ul style="list-style-type: none"> - clearly connected to other characteristics
Evidence (signs) of chemical change	<ul style="list-style-type: none"> - vastly applied to judge the type of change, incorrectly sometimes - understanding is not solid/consistent <p>Misconceptions/difficulties:</p> <ul style="list-style-type: none"> - not aware of why the given signs are considered as signs of CC - 'possibility' of the signs is not taken into consideration <p>Back to teaching:</p> <ul style="list-style-type: none"> - no explicit discussion of the 'possibility' point - no explicit discussion of the justification behind the signs as evidence of CC 	<ul style="list-style-type: none"> - vastly applied to judge the type of change, incorrectly sometimes - understanding is not solid/consistent <p>Misconceptions/difficulties:</p> <ul style="list-style-type: none"> - not aware of why the given signs are considered as signs of CC - 'possibility' of the signs is not taken into consideration <p>Back to teaching:</p> <ul style="list-style-type: none"> - no explicit discussion of the 'possibility' point - no explicit discussion of the justification behind the signs as evidence of CC

Table 10.6: Comparison between the pupils' understanding in stage 1

Stage 2 'Electric Circuit'	Case 1	Case 2
Charges	<ul style="list-style-type: none"> - pupils have the scientific conception of the charges as originating in the wires and not in the battery - considered as axiomatic in understanding the working of electric circuit <p>Back to teaching:</p> <ul style="list-style-type: none"> - pupils had the chance to present their misconceptions regarding the source of charges and to develop themselves the scientific view 	<ul style="list-style-type: none"> - pupils have the scientific conception of the charges as originating in the wires and not in the battery <p>Difficulties:</p> <ul style="list-style-type: none"> - rarely included in the argument in answering the given questions <p>Back to teaching:</p> <ul style="list-style-type: none"> - pupils had not get the chance to develop the idea of the charges in the wire slowly and gradually - discussed largely within the context of the role of the battery
Current	<ul style="list-style-type: none"> - good and consistent understanding of 'Current' in terms of: - simultaneous movement of charges - constant intensity (current is the same everywhere in the circuit) - instant lighting of the bulb - the role of the current in lighting the bulb and explaining the working of electric circuit <p>Back to teaching:</p> <ul style="list-style-type: none"> - pupils had the chance to present their misconceptions regarding the movement of charges, instant lightning & steadiness of current, and to develop themselves the scientific views 	<ul style="list-style-type: none"> - 'Current' as a term was absent from the pupils' talk, not used explicitly hence in explaining the working of electric circuit - the idea of simultaneous movement of charges is not solid/consistent <p>Misconceptions/difficulties:</p> <ul style="list-style-type: none"> - movement of charges is not conceptualised as a 'current' - movement of charges is only raised within the context of the role of the battery - sequential thinking in approaching the movement of charges related to sequential thinking about distribution of energy <p>Back to teaching:</p> <ul style="list-style-type: none"> - pupils had not get the chance to develop the idea of simultaneous movement of charges gradually - discussed largely within the context of the role of the battery
Energy	<ul style="list-style-type: none"> - good understanding of the battery as the source of energy, energy is transformed to light in the bulb, energy is consumed & equal distribution of energy - confusion about what energy is and how it is distributed <p>Misconceptions/difficulties:</p> <ul style="list-style-type: none"> - few utilise sequential model in thinking about the distribution of energy - few utilise a 'package' image in thinking about the nature of energy and how it is transferred <p>Back to teaching:</p> <ul style="list-style-type: none"> - pupils had the chance to present their ideas on the source of energy and its transformation and to develop the scientific views - reinforced the package view of energy, indirectly - entity of energy was not discussed explicitly 	<ul style="list-style-type: none"> - good understanding of the battery as the source of energy, energy is transformed to light in the bulb & energy is consumed - confusion about what energy is and how it is distributed <p>Misconceptions/difficulties:</p> <ul style="list-style-type: none"> - utilise sequential model in thinking about the distribution of energy - utilise a 'package' image in thinking about the nature of energy and how it is transferred <p>Back to teaching:</p> <ul style="list-style-type: none"> - pupils had the chance to present their ideas on the source of energy and its transformation and to develop the scientific views - attention was directed to perform & discuss activities on the battery roles without discussing the nature of energy and how it is transferred - pupils faced a difficulty in mapping the links of activities to how the electric circuit works
How the electric circuit works	<ul style="list-style-type: none"> - correct/ and few incorrect answers to the given problems - solid understanding of how the electric circuit works in terms of charges specifically and current more generally <p>Misconceptions/difficulties:</p>	<ul style="list-style-type: none"> - confused correct/ incorrect answers to the given problems - confusion in explaining how the electric circuit works in relation to the movement of charges and distribution of energy <p>Misconceptions/difficulties:</p>

	<ul style="list-style-type: none"> - some faced difficulty in explaining how the electric circuit works in relation to distribution of energy - difficulty with the ‘energy’ entity <p>Back to teaching:</p> <ul style="list-style-type: none"> - attention was paid to the misconceptions about charges in terms of a sequential model - reinforced the equal distribution of energy - Less attention was paid to exploring energy’s misconceptions of the sequential model and the package-view - less discussion went paid to the basic entity of energy 	<ul style="list-style-type: none"> - suspecting the instant lightness of a bulb in electric circuit - The connection between the role of the battery as pushing the electrons and providing them with energy is not clear - The package view to energy and sequential model in thinking about transfer of energy <p>Back to teaching:</p> <ul style="list-style-type: none"> - rare explicit discussion of how functions of the battery are connected - reinforced the equal distribution of energy - implemented activities were complicated and CT focused on indirectly related issues
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Table 10.7: Comparison between the pupils' understanding in stage 2

2.1. Reflecting on the outcomes of 2.1 & 2.2, how is the pupils’ learning influenced by CT Dialogicity?

The second part of Chapter 9 (section 9.2) has been allocated to discuss the study’s findings on CT Dialogicity in relation to pupils’ learning, General results pointed to the potential of Dialogic talk to supporting pupils’ learning over Authoritative talk. However, I argued that it is not possible to establish a constant claim on this potential because the comparison between the two types can be approached differently, depending upon which of their levels are being compared. Alternatively, it has been suggested that the relationship between CT Dialogicity and learning is better approached in the light of the continuity view within the ‘less-more’ dialogic model. Accordingly, different claims on the advantages of more dialogic talk over less dialogic in supporting pupils’ learning have been suggested in relation to the three broad issues of:

1. Characteristics of Authoritative and Dialogic types

The findings suggested that more dialogic talk/practice appear to have advantages over less dialogic because of differences in characteristics. These advantages have been viewed as opportunities more likely to be offered by more dialogic types of talk. These are:

- Opportunity to talk and listen
- Opportunity to express and explore understanding
- Opportunity to work on understanding
- Opportunity to develop habits of thought and engage in argument practice
- Opportunity to value individual differences

2. Cognitive level of questions and responses

The overall results of this study proved the potential of Dialogic talk to invite questions and responses of high cognitive level, whereas Authoritative does not. However, it has been explained that restricting this potential to Dialogic type and inhibiting it for the

Authoritative talk altogether is not supported by the findings of this study. Nevertheless, the findings support the claim of the ‘potential of more dialogic CT to invite questions and responses of high cognitive level and the lower potential of less dialogic CT to do so’. The results also confirmed the finding found in literature of the non-cognitive correspondence between questions and responses of the high level. Nevertheless, they proved a *tendency* of high level questions to call for high level responses, supporting therefore the assumption that the types of questions the teachers ask can, to some extent, influence the cognitive processes that students engage in through the process of knowledge construction.

3. Pupils’ resultant shared knowledge

The relationship between CT Dialogicity and pupils’ learning has been discussed also in view of the nature of the common knowledge that the participating pupils appeared to share subsequent to the teaching. This discussion was based on the assumption stated by this study that:

Difference(s) in the constituted common knowledge between different teaching practices can be attributed to some extent to difference(s) in the type of the exchanged talk through those practices (refer to section 9.2.3)

Taking the nature of the resultant common knowledge as to consist of desired scientific knowledge as well as undesired conceptual difficulties and misconceptions, and having all the results from the two cases together, the following insights have been drawn:

- There is a tendency of the practice of more dialogic CT to result in a more solid scientific understanding. This means that the more the CT is ‘more dialogic’, the higher is the probability that the common knowledge the pupils appear to share will consist of more scientific conceptions and explanations and less misconceptions and conceptual difficulties.
- The pupils who shared the same teaching and classroom interaction experiences, did not appear to necessarily share the same knowledge. Most importantly, when the teaching was of less dialogic CT, there was a gap in the understanding between individual pupils more persistent than the one following from the teaching practice of more dialogic CT. It has been suggested, accordingly, that the more solid the understanding that is developed by a group of pupils, the less is the gap in understanding between them as individuals.

As shown by tables 10.6 and 10.7, following learning in its relation to CT Dialogicity has been examined not only in the light of the overall characterisation of the quality of CT, but also by tracing the results on pupils’ understanding back to the teaching. This strategy of analysis added to the reliability of the finding that the pupils’ conceptual understanding of a certain scientific issue is evidently influenced by the overall teaching practice in general and by the quality of CT on this issue in particular. This has constituted the base for the statement

that learning does not stand in isolation from teaching in the first place.

In the light of the summarised results and findings, I sum up in the next section the main implications of this study's theoretical and empirical exploration of CT Dialogicity in relation to teaching and learning.

10.2 Contribution and implications of the study

This study provides a clear and well-illustrated case for the significance of spoken language in classroom settings in shaping the teaching practice and contributing to pupils' learning. In the previous chapter, I raised a number of issues and lines of argument that have their implications for research. In this section, I comment on the contribution of this study and its implications for research and teacher training.

10.2.1 Methodological innovations

In exploring the nature of CT, this study has attempted to extend the sociocultural tradition in classroom studies by looking not into teaching only or learning only, but by looking into the link between the two processes. Its main aims and theoretical assumptions have been set to identify the position of CT Dialogicity in relation to both teaching and learning. Also, the research design, methodology, analysis and discussion have all been guided to provide insights on the two processes and how they are linked by the characterised talk. Accordingly, the emphasis has been placed on how CT Dialogicity characterises teaching and how it contributes to pupils' learning. Moreover, by examining what knowledge has been generated and tracing back how this knowledge had been communicated through the teaching practice, the study provided a demonstrated empirical link between teaching and learning in relation to CT. In doing so, the study implemented innovative methodological approaches to analysing CT and investigating pupils' learning. These appeared in three main practices:

The analytical framework

Analysed examples drawn from interactions in classrooms are needed to illustrate any discussion or implication for the practice of teaching and learning: how pupils develop their knowledge, conceptual understanding and intellectual and thinking skills; and how teachers contribute to this development. Hence, developing the approach to discourse analysis is absolutely important for CT studies. Indeed, discourse analysis through the application of the analytical framework is the underpinning empirical base of this study. In developing it, a wide range of ideas have been operationalised driven by contributions from related literature as well as by reflective scrutiny of the generated data. Accordingly, the framework came to suggest a new approach to analysing CT by going simultaneously into two directions;

broadening the aspects of analysis on one hand, and going deeply into analysing each aspect on the other hand. This has been achieved by employing several strategies that classroom studies might make use of in future research. The framework followed a systematic analysis of CT by looking into the structure of the talk, yet offered a detailed and context-based analysis of the content and the functions of the talk. It examined the talk qualitatively, yet offered a quantitative output of some of the qualitative acts. The numbers provided a description of some features of the talk that the qualitative presentation alone could not show. Moreover, it did not pay attention to only characterising the teaching context of the analysed CT as is usual in classroom talk studies, but investigated elements of learning as well- a practice that is rarely employed by the approaches to discourse analysis.

The stages of analysis

In spite of the different novel elements that the framework entailed and which resulted in a detailed and rich analysis of CT, the application of this framework represented only one of three stages of analysis. These stages allowed the examination of CT to go back and forth between general and specific results utilising qualitative analysis and quantitative measures. By doing so, the study provides an illustrated case for how research on CT can respond to the complexity of the phenomenon of CT by triangulating the analysis and providing different lenses in looking into it. Furthermore, I believe that this staged analysis offers a new approach to understanding the context and how to get further access to it. The context, in this sense, does not constitute only the information that we can gather directly from the research tools and strategies, but also from initial analysis of the generated data. For example, the results from the surface analysis in describing the overall percentages of the communicative approach classes provided a general description of the observed classroom practice, offering in turn some information about the context of the Authoritative and Dialogic talk characterised through the following stages. The same can be said about what the quantitative representations of the follow-up types and the quality of questions and responses have provided.

The investigation of learning

Studies on CT rarely focus on investigating pupils' learning as has been pointed out previously (refer to section 2.1.1). This study does not provide empirical research in filling this gap only, but proposes a pioneering approach to performing this investigation by focusing on both, learning as a process and as a product. Certainly, there has been previous strong education research on investigating pupils' understanding/achievement that reflect learning as a product. However, I have not come across CT studies that looked into pupils' understanding in relation to the quality of the CT practice apart from some before the 70s (refer to section 2.3.2.1), which examined general measures of pupils' achievement rather than following their

detailed conceptual understanding as this study does, and furthermore tracing this understanding back to what was going on in the teaching. Additionally, the Dialogicity of the talk has been directly linked to pupils' learning by looking into some indicators on learning as a process, of the pupils' engagement, developing understanding and cognitive level of questions and responses. The study has operationalised, in fact, the cognitive levels as presented by Bloom (1956) in a new context by taking it as an indicator of pupils' learning in relation to CT Dialogicity. Generally speaking, doing the qualitative categorisation of the quality of questions and responses of the analysed CT and further putting it into a quantitative representation, has proved to be a useful methodological strategy, and contributes accordingly to providing established empirical approaches to examine the influence of CT practice on pupils' learning.

In making these methodological choices to investigating learning, the study was guided by the argument initiated through the literature review (section 2.1.3) concerning views of learning. It has been explained that although learning science is viewed as both, individual (cognitive) and social (e.g. Driver et al., 1994; Leach & Scott, 2003; Mercer & Littleton, 2007), it is mostly investigated as solely cognitive or solely social. The argument initiated suggests that learning as shaped by the language of classroom is better investigated as combining the cognitive and the social actions (shaped by the context of the learning setting), and although the relation between the two is complex, it is well worth to be explored in detail. In defending the view of knowledge as a joint possession, Mercer (1995) declared that thinking of it only as an individual mental possession "does not do justice to it, or to the capabilities of human beings" (p.1). Given however the current trend of focusing on the social perspective in investigating learning and discounting the individual one, then it can be also argued that 'thinking of knowledge only as a joint possession does not do justice to it, or to the capabilities of individual human beings'. This study was faced by the uncertainty of how to examine pupils' learning from the individual view along with the social one (section 2.1.3). However, the synthesis of different methods and strategies in doing this has produced results that support the significance of the insights on the individual influence and differences to offer a more substantial and accurate picture of the learning overall (refer to section 9.2.3). In fact, I consider that this study provides an illustrated application of the sociocultural theory of learning and development proposed by Mercer and Littleton (2007) as applicable to CT (refer to section 2.1.3) by taking account of the relationship between the three levels of human activity: the cultural/historical, the individual/cognitive and the social/interactional.

10.2.2 Innovation arising from the findings

In line with the methodological approaches used to generate and analyse data to meet its aims and research questions, this study has drawn on extensive literature, and closely related the insights from literature to the empirical research findings from real-life Omani teaching and learning practices. This has resulted in raising new lines of argument, developing existing practical tools and offering some evidence on the investigated issues.

Dialogicity and teaching

Expanding the Authoritative-Dialogic categorisation drawn by the CA in this study led to a new model of empirical Dialogicity; i.e. the multilevel 'Authoritative-Dialogic'. This model advances the field by identifying sub-levels of Authoritative and Dialogic communicative approaches. The CA as presented by Mortimer and Scott (2003) in their book offer excerpts of CT that clearly exemplify the four classes. However, experience in working with many and different episodes of CT shows that it is not always easy to fit them in the four boxes of the CA. The 'multi-level' model offers a practical tool that responds to this difficulty by suggesting multiple levels of each type of talk and detailing their characteristics. Additionally, reflecting on this empirical model through a speculative playing with ideas in the light of some of the reviewed literature, has shaped the theoretical model to approaching CT Dialogicity. The study raised some hypothetical ideas in describing the features and significance of the suggested model of 'less-more' dialogic and how different categories labelling CT in classroom interaction studies can be perceived from the Dialogicity perspective as drawn by this model.

These ideas as well as the suggested development of the CA have been theoretically informed and empirically examined and developed. It requires however more research to test and apply them to different contexts and practices to find out how far they work and reshape them in the light of new results and gained insights. Indeed, it would be a contribution, for example, to apply some of the presented speculative ideas on the theoretical model of CT Dialogicity to argumentation studies, having in mind the increasing and consistent focus on this area in science education research and its close resemblance with what is described usually as dialogic practice concerning, specifically, their suggested role in promoting the learning of science content. Research on 'dialogic teaching' is another area through which such ideas on CT Dialogicity and the overall insights presented in this study can be worked out. I argued actually that investigating 'dialogic teaching' in the light of the continuity view that shapes the 'less-more' dialogic model might be useful in progressing what Scott, with other colleagues, have started; conceptualising it as a *tension between Authoritative and Dialogic types*, taking it away from being restricted to dialogic

talk only (see Scott et al., 2007; Scott & Ametller, 2007; Scott et al., 2006). In line with this conceptualisation, I suggested that dialogic teaching can be viewed as a *tension between the different levels of Authoritative and Dialogic types* in view of the ‘multi-level’ model or as a *tension between less and more dialogic types* in view of the ‘less-more’ dialogic model (refer to section 9.1.3). In the main, the findings from studies characterising the nature of CT generally and in relation to its Dialogicity in particular are central to the research on ‘dialogic teaching’ and ‘dialogic education’.

Dialogicity and learning

The study provides compelling evidence to illustrate that the quality of CT influences the pupils’ engagement, intellectual skills and conceptual understanding. It suggests that improving the quality of talk between teachers and learners is of crucial importance if teaching practice is to have a significant influence on learning. By using evidence of how pupils engage in, share control over CT and influence its direction, and how their construction of knowledge and understanding change as the quality of the exchanged talk in their classroom practice change, this study provides empirical findings that are missing from the field. These findings can be further elaborated by educational researchers in the science education area specifically. This is essential to explain how CT contributes to the pupils’ understanding and educational attainment.

Nevertheless, although the study contributes to a body of evidence that dialogic practice has a positive influence on pupils’ learning, it initiates a rather new direction in how to connect learning to the practice of CT, focusing on its Dialogicity specifically. Such a connection, the study argues, cannot be reliably drawn within the ‘Authoritative-Dialogic’ (or any similar Dialogic/not Dialogic) categorisation. The findings indicate that Authoritative talk of lower level supports pupils’ learning even more than Dialogic talk of lower level does in some respects. Consequently, the study argues that the claim of the potential of more dialogic talk (given that it refers to Dialogic talk of higher level and Authoritative talk of lower level) over less dialogic to support learning can easily be made in line with the reported results rather than restricting this potential to Dialogic talk only. Given that the ‘less’ and ‘more’ dialogic labels within the suggested theoretical model to approaching CT Dialogicity can be attached to different types of talk categorised in literature as proposed by this study, then such a line of argument in approaching how learning is influenced by CT can be utilised or investigated by other CT studies.

Moreover, the study offers some preliminary results on the similarities and differences in the indicators of learning between different types of talk derived from the analysis of discourse during the instruction. Studies concerned with investigating classroom interaction in relation to learning in general, and those focusing on learning as a process particularly,

might make use of these results. Generally speaking, I envisage two lines of research that can contribute to this area of research:

- The first relates to following the development of conceptual understanding as indicated by the CT during the act of teaching itself (see for example Eshach, 2010).
- The second focuses on how students utilise their conceptual understanding while acting in normal learning settings; i.e. how pupils incorporate their conceptual understanding while they talk. This is a trend that has been started in argumentation studies (e.g. Aufschnaiter, 2010), though I have not come across it in other CT studies.

In fact, both kinds of study need to ensure that the researcher can access the pupils' conceptual understanding, to examine how it develops in the first strand, and how it is incorporated in the talk in the second. As claimed by this study, Authoritative talk from mid and higher levels alone does not make it possible to access the pupils' understanding. This requires the CT to be of a quality that reveals the pupils' views and allows them to speak out their thoughts throughout the teaching, in addition to the type of talk through which the teacher can present and develop the scientific view. This means that the teaching to be observed in such strands of research needs to be 'dialogic' in the sense that it attends to the different less and more dialogic types of talk.

What is more, through the review of the systematic approach to discourse analysis, I turned to its focus of investigating the emotional climate concerning both teachers and pupils; a feature that diminished after the 70s and was rarely discussed explicitly in later studies adopting insightful analysis within sociolinguistic and sociocultural approaches. This study has not discussed the emotional relationship established between teacher and pupils independently. Nevertheless, It did shed light on some features of this relationship in different incidents like explaining, for example, about the motivation of pupils, the teacher's neglect of or openness to pupils' thoughts, the smoothness of the talk between teacher and pupils and the mis-communication between them. Confirming what Sutton (1992, p. 79) has stressed that language does not have a cognitive function only but an emotional one as well, future research on classroom interaction might need to relive this feature of the systematic approach in paying careful attention to the emotional climate in classrooms within the implemented approach to analysing CT.

10.2.3 Teacher training

What this study offers on different issues regarding the nature of CT and its contribution is not only relevant to the academic study of teaching and learning practice and CT Dialogicity; it is also of practical value to teachers who are concerned with ensuring that their pupils are offered better learning opportunities. Effective use of talk in the practice of

teaching and learning is central to the teacher's professionalism. This study presents some theoretically informed/empirically tested ways and suggestions that can be utilised for teacher training, resulting from different sources of experience. One of these experiences comes from the TI planned and conducted for the participating teachers. Although it was of a short-period including limited resources and activities, it achieved its purpose of helping the teachers to try more dialogic practice, leading thus to generating rich data of different types of CT needed by this study. In fact, the Arabic resources that have been developed for this intervention can be further developed to be used for a longer and sustained training for teachers in the Arabic-speaking world.

As pointed out before (refer to section 5.5.4), however, changing the quality of talk in the classroom necessitates changes in professional practice which cannot be reduced to a one-shot training session. It is not easy as it requires effective training, adequate time and resources, support and cultural change, among other requirements (Keogh & Naylor, 2007). This study does not claim that it has made a sustained change in the professional practice of teachers, yet it has met its planned purposes, so that its experience might be of use for studies working on a similar research context. Nevertheless, what this study has followed in terms of methodological approaches to analysing data, and what it has produced in describing the nature of talk and its quality through different styles of presentation, all provide valuable inputs for a sustained programme of teacher training to promote dialogic talk and dialogic teaching more generally.

The four issues included in answering research question 1.2 concerning the features of the Authoritative and Dialogic types (refer to 10.1 above) offer a wide range of information that can be incorporated in such a program. What is unique about these issues is how detailed and diverse is the characterising of the nature of CT; detailed characteristics of different types of talk, detailed and exemplified strategies for more dialogic practice and detailed accounts of what might influence the type and level of talk. Such detailed information is expected to offer a clearer description of what constitutes Authoritative and Dialogic talk, so that the teachers can discuss their practices in view of it. Telling them that the pupils as well as the subject matter can have an influence on how the talk progresses, and providing them with some ideas about how they do so can be useful and engaging. Moreover, what this study provides by way of evidence on how learning as a process and as a product is influenced by the quality of CT is a powerful example of what is needed to convince teachers in such a programme that dialogic practice has its rewards in supporting pupils' learning. In this context of convincing and engaging teachers with the issues in discussion, two methodological strategies that were used by this study are absolutely important:

- The first relates to offering quantitative and graphical representations of the discussed

issues. One can see how the numbers and pie-charts offered throughout the analysis of this study provide an 'at a glance' view of the discussed issues. They summarised the whole teaching by giving the percentages of each of the practised classes of talk, described and differentiated between different practices by quantifying the different types of follow-ups, and supported claims about pupils' learning by quantifying the quality of questions and responses. Such results that this or similar studies can provide need to be integrated in teacher training, but most importantly it might be useful for the training programme itself to operate these strategies in its design to support and evaluate the practice of the trainee teachers.

- The second relates to using examples of talk to support the discussed issues. In carrying out the analysis, this study relied on providing excerpts of talk to exemplify and clarify the presented results. Sometimes, it involved taking a whole chunk of CT and at other times taking single utterances from different incidents of talk. Regardless of different ways of presentation, these examples were the backbone of the analysis, which gave it credibility and validity. Likewise, the strategy can be employed to support discussion during a training programme. In fact, the experience of this study in piloting the workshops of the TI has shown that the second workshop was less effective; partly because of the absence of examples of talk in demonstrating certain uses of Dialogic talk. It also showed that examples from the context that the trainees are coming from are more convincing than using ones from a different context (refer to section 5.5.4).

What is more, for an intense programme of teacher training, the multilevel Authoritative-Dialogic' model developed from the CA can be employed to characterise the progression of the teachers. Similar to the procedure in this study, trainee teachers can be observed prior to and after certain stages of the training, and their progress can be followed. Using the figure of Authoritative and Dialogic levels to advise the teachers about where they were and how far their practice has developed, can be a powerful tool to promote dialogic practice. Telling them that they do not have to jump from Authoritative to Dialogic; rather that they can progress in their dialogic practice, that some of the talk they guide can be dialogic but not Dialogic, that Authoritative talk of lower levels is worthwhile, that Dialogic talk of lower levels is not enough; all such insights suggested by this empirical model can benefit their training. Such insights can engage and motivate the teachers because they convey the message that different CT practices are needed and that the development of these practices is an ongoing and sustained process that needs time and experience, but one which they can be guided through. This can in turn empower the teachers to use the different levels of the two types of talk appropriately and effectively.

For academic research, such insights can also be of use in studies looking into how teachers implement dialogic, or similar approaches to teaching (see for example, Kerlin, McDonald, & Kelly, 2009; Lehesvuori, Viiri, & Rasku-Puttonen, 2010; McDonald & Songer, 2008). Indeed some of the insights presented throughout the study join the ever-existing debate on teachers' professional development on the whole (concerning for example; time and curriculum constraints, teachers' skills and views of science, pupils' skills and views of learning, power and control concerns). In dialogic practice, there are different responsibilities for both the teacher and pupils that require them to take on what might be a different role from what they are used to. More research on this area is needed to reinforce dialogic practice for teaching and learning.

10.3 Limitations of the study

Denscombe (2002, p. 126) stated that: "The researcher is obliged to confront the reality of limited resources and less than perfect research tools, and eventually strike some kind of balance which involves a trade between competing demands and priorities". Striking such a kind of balance was a continuous concern for this study. Between the breadth of the design to involve four cases and to investigate the teachers' and pupils' views on one hand, and its depth to utilise different research strategies and different stages of analysis on the other, I had to find a balance. Time and space constraints limited also the results to be reflected on in Chapter 9, and more explanation of those discussed. Moreover, re-placing the analysis chapters of case two in the appendices was not really a choice.

Hence, the study has been limited by decisions of reducing data and giving up some of its content. Besides, the depth of analysis and the broadness of the research questions, along with the time and space constraints, have resulted in different raised issues that could not get enough attention, and which need to be examined through further investigation. Certainly also, the study is limited by its underlying assumptions as well as by my objectivity as a researcher in doing, interpreting and reporting the whole process of the research.

10.4 Final thoughts

Looking at this study as a whole just makes me realise that it is indeed a work in progress. Still more needs to, and can, be done in analysing existing data and reflecting on gained results. Time, space, and my limited research experience seem to have interfered with this progress. My hope is that what this thesis offers can contribute to opening wide the window on what I regard as an essential concept in approaching the nature of CT; that is of 'Dialogicity'. I consider that characterising CT from the Dialogicity perspective can contribute to improving our understanding of how the conditions of teaching and learning can be advanced. However, studies in this area need to be explicit about the educational level of

Dialogicity under investigation, and to identify how Dialogicity is approached at the theoretical and empirical levels.

CT studies in general need also to move from only describing the CT in teaching practices to also investigate the learning associated with and following from these practices, and to identify the teachers' and pupils' views and attitudes towards them. Planning to change existing CT practices, what to and how, should all be based on the findings from such areas of research, and not to be only driven by theoretical critique and visions of what might work better. Yet, this is a complicated and tricky area that requires a very careful research. On the one hand, the whole picture is multifaceted and overlapped- if we can basically claim that there is a whole picture. Studies can neither agree over one whole picture to guide research, nor can they reach to the anticipated one. On the other hand, different claims can be made for similar teaching practices in different contexts. Nonetheless, well-planned and carefully-implemented research in different contexts has provided valuable insights and is contributing to improving the process of teaching and learning.

I do hope that I can advance my work in this study by making use of the methodological approaches developed, the suggested findings, and the proposed speculative ideas and to further develop them. To this end, I remain unsure of how CT Dialogicity can be interpreted in the larger domain of CT studies. My interest is to further develop the concept of Dialogicity in characterising CT and to link it to other categorisations and classifications of talk in different strands of CT studies.

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