



Talking science in a second language

The interactional co-construction
of dialogic explanations in the
CLIL science classroom

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My grandfather's microscope

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CLIL science classroom

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PhD Dissertation

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A Juan Carlos
Gracias por todo

Моей матери
За то, кто я есть

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CHAPTER 1: INTRODUCTION

1.1. CHAPTER OVERVIEW

This introductory chapter begins with a brief presentation of the topic treated in the dissertation (section 1.2). It continues by outlining sociolinguistic situation in Catalonia (section 1.3) and Content and Language Integrated Learning approach (section 1.4), both of which serve as general contexts for the study. Then, the chapter situates the study within the DALE-APECS research project (section 1.5). It concludes with an overview of the study, its objectives and structure (section 1.6) and the chapter summary (section 1.7).

1.2. TO START WITH...

In a recent conference on education in Gerona (Spain) where children were invited to speak to adults a ten-year-old told the audience referring to lessons taught in her L1: 'I would be good at maths if only did I understand the words the teacher uses in the classroom'. For this girl, academic language seems to be a sort of *foreign language* full of new terminology, false friends, obscure concepts and discourse rules that do not match those she is familiar with. From her story it can be inferred that the teacher is not aware of – and therefore does not act consequently – the fact that the lesson taught in the L1 often creates an illusion of a common transparent language shared by the teacher and the students which allows trouble-free understanding between the two parties. In the case of this and many other students, however, the L1 acts as a thick glass screen, apparently transparent but impenetrable to academic messages and mutual understanding (see e.g., Escobar Urmeneta, 2009).

What happens to the teaching and learning of school subjects in lessons in which the language of instruction is a foreign language is what this piece of work is about. It focuses on a secondary school in Catalonia which runs a Content and

Language Integrated Learning (CLIL) programme. The reader will be invited to observe and analyze conversations between a CLIL biology teacher and her twelve-year-old students as well as to draw conclusions which may be used to further the understanding of intricacies of such educational context. What has been learned through the detailed analysis of empirical CLIL data may render helpful for the formulation of proposals and suggestions for teachers and classroom teaching practices.

The interpretation offered above finds support in current research that shows that learning a discipline necessarily requires internalizing the *specialized discourse* used by the experts in the field when they construct the discipline's knowledge (see section 2.6). In this respect, disciplinary discourse is a complex tool of linguistic nature. Hence, an assumption may be put further that the disciplinary discourse is the *locus* where the integration of language and content occurs. Defining the characteristics of subject-specific discourse used to construct school academic knowledge – *science* in the case of this study – in the particular communicative situation where students have a limited command of the language of instruction is essential to understanding how CLIL teachers make the necessary pedagogical and discursive adjustments to enable students to acquire subject content and the target language simultaneously. To gain this understanding it is necessary to focus on the specific discourse that emerges in the CLIL science classroom. This is what the given study is aimed to do by carrying out a close analysis of interaction in one CLIL science classroom in Catalonia.

1.3. CATALONIA, A COMPLEX SOCIOLINGUISTIC SETTING

Within the Spanish State, Catalonia is a bilingual region from a legal and a sociological point of view, where both Catalan and Spanish are co-official languages. Such sociolinguistic situation has been achieved over the last decades due to important changes in the status of Catalan – the minority language – in society and particularly in education where it had been banned for almost forty years during Franco's regime (1939-1975). In early 1980s, one of the crucial steps in promoting Catalan was the Act on Linguistic Normalization (Generalitat de

Catalunya, 1983). This key policy document reflected the decision of the Autonomous Government of Catalonia to introduce Catalan immersion programmes into primary education (Escobar Urmeneta and Unamuno, 2008; Nussbaum and Cots, 2011). At that stage, though immersion programmes implemented in Catalonia mainly followed the Canadian model of early total immersion¹ – which has been shown to give positive results in students’ language development in both first language (L1) and second language (L2), as well as in their academic achievement and affective development (see Lyster, 2007 and Genoz and Jessner, 2000 for comprehensive reviews of research on Canadian immersion) – they however took into account sociolinguistic circumstances which resulted specific to Catalonia.

Later on Decree 75/1992 generalized the use of Catalan as a language of instruction for content subjects in infant and compulsory education thereby extending early total immersion to other educational levels. As Escobar Urmeneta and Unamuno (2008: 230-231) note,

Catalan immersion was the basis for the consolidation of a unique network of schools, from the linguistic point of view, which adopted Catalan as their main working language for the whole school community, at the same time as guaranteeing adequate exit levels in Spanish for all students.

Such measures resulted in an exemplary and unique model of immersion education in Europe (e.g., Arnau, Comet, Serra and Vila Mendiburu, 1992; Artigal, 1991; Vila Moreno and Vila Mendiburu, 1998) which received the support of independent national and European evaluations (see e.g., Arnau, 1985, 2004; Council of Europe, 2005) and a majority acceptance from the Catalan society.

¹ According to Swain and Johnson (1997), the prototypical Canadian immersion programmes had the following basic characteristics: (a) students who shared the same majority language (English) were exposed (usually from an early age) to a second – minority – language (French) which was used as a language of instruction; (b) such exposure was however mainly confined to the classroom; (c) students entered with similar (and limited) levels of proficiency in the target language; and (d) immersion teachers were bilingual. However, more recent research on Canadian immersion reveals that in majority of cases (a) immersion students no more share the same first language and (b) the target language no longer represents the second language for such culturally diverse and multilingual students (Swain and Lapkin, 2005).

In 2004, due to an increasing number of newly immigrated students who were found to often lack basic linguistic competences or even previous formal schooling, Catalan authorities established a new education policy. Reflected in the Language and Social Cohesion Plan or LIC (*Pla per a la llengua i la cohesió social*, Generalitat de Catalunya, 2004), the new policy has a two-fold objective: (a) to promote Catalan inside and outside school by guaranteeing the right of everyone to use it in all aspects of everyday life and (b) to avoid the social exclusion of immigrant students by helping them to acquire academic and conversational competences necessary to participate in monolingual practices in Catalan (Nussbaum and Cots, 2011).

In this complex sociolinguistic situation, yet one third – foreign – language, this being mainly English², is slowly but steadily gaining grounds as a language of instruction in Catalan schools, ratifying once more the Catalan aspiration of combining “*linguistic policies aiming at (apparently) opposing targets (...) promoting a vernacular language and adopting global policies which favour the free circulation of workers and goods across Europe*” (Escobar Urmeneta and Unamuno, 2008: 229). Contrary to Catalan, English is a truly foreign language for students in Catalan schools as, on a general bases, it is only available to learners in institutionalized settings for an average of three EFL lessons per week since the age of six (Escobar Urmeneta and Nussbaum, 2010).

In these settings, a growing acceptance by practitioners, researchers and educational policy-makers in Catalonia of a pedagogical approach aimed at teaching different school subjects through a foreign language gains a particular relevance. This and other similar teaching approaches are known as *Content and Language Integrated Learning* (CLIL)³.

² French and German are usually offered as optional second foreign languages in secondary education (Escobar Urmeneta and Unamuno, 2008).

³ It is also known as *Enseignement d'une matière par l'intégration d'une langue étrangère* (EMILE), in French, and *Aprendizaje Integrado de Contenidos y Lengua* (AICLE), in Spanish.

1.4. CONTENT AND LANGUAGE INTEGRATED LEARNING AS A STRATEGY FOR THE PROMOTION OF PLURILINGUALISM

A growing phenomenon in Europe, CLIL is a successful umbrella term used to design 'a wide range of educational practices and settings whose common denominator is that a non-L1 is used in classes other than those labelled as 'language classes' (Dalton-Puffer, 2007: 2). An increasing body of research work in Europe carried out in different sociocultural, sociolinguistic and educational contexts and on different subject-matters strongly evidences positive outcomes for CLIL students' linguistic achievements (e.g., Dalton-Puffer and Nikula, 2006; Dalton-Puffer, Nikula and Smit, 2010; Dalton-Puffer and Smit, 2007; Escobar Urmeneta, 2008; Escobar Urmeneta, Evnitskaya, Moore and Patiño, 2011; Escobar Urmeneta and Nussbaum, 2008; Lorenzo, Casal and Moore, 2010; Ruiz de Zarobe and Jiménez Catalán, 2009).

In the last decade CLIL approach has been favoured by the European language policies both in compulsory and tertiary education as a preferred educational option in order to generalize plurilingualism among the European citizens (Council of Europe, 1992; 2008; Eurydice, 2005). On the other hand, it is becoming a buzz remark among practitioners and society in general to insist that CLIL programmes put too much pressure on many students and that these students should be protected by advising them to choose non-CLIL options, where they could better develop key competences in their L1.

This line of thought may become a severe threat to equity in education as CLIL programmes run the risk of enacting the Matthew effect by privileging the already favoured students, while leaving aside the less fortunate ones (Escobar Urmeneta, accepted; Escobar Urmeneta and Jiménez Jiménez, in progress). The 1+2 European language policy, which aims at learning two foreign languages in addition to the students' L1, becomes even more relevant in the context of already bilingual Catalonia where it transforms into 2+2. Yet, only a limited number of students, namely, those who learn a second – optional – foreign language may attempt to pursue this objective. The common practice in Catalan schools rather tends to be 2+1. This is precisely the educational context analyzed in this study.

Hence, if any of these formulae to succeed, CLIL needs to be a democratic option that suits all types of learners and their needs. A more restrictive definition by Escobar Urmeneta (2011: 203-204) below helps identify those teaching practices that lead to the democratization of the CLIL approach:

Content and Language Integrated Learning or CLIL embraces those educational practices in which content subjects – excluding those labelled as ‘language subjects’ – are taught and learned through a language of instruction, second or foreign, in which a learner has a basic or advanced developing communicative competence, and which explicitly:

1. Promote the preservation and development of the learner’s first language(s) and the consideration and *misse en valeur* of cultural forms attached to that (those) language(s);
2. Promote a truly integrated approach, with a dual focus of pedagogical attention, i.e. language and content;
3. Provide learners with all the assistance needed to comprehend, produce and negotiate academic messages in the target language adopted as the medium of instruction.

Apart from providing clear criteria for the identification of quality CLIL teaching practices, this definition also implicitly speaks about the co-existence of at least two different languages in CLIL classrooms: language of instruction, that is, target second language⁴ and first language(s), both of which can be (or should be?) involved in the teaching-learning process. This raises an issue of using a term ‘non-linguistic subject’ (NLS) – often found in CLIL research – in relation to classrooms in which school disciplines other than languages are taught. In her definition of CLIL provided at the beginning of this section, Dalton-Puffer cleverly presents an alternative to the term. Because if ‘the construction of knowledge is mainly verbal [and] interactional’ (Gajo, 2007a: 566), how can any subject-matter be labelled as *non-linguistic*? And putting it even further, how can any target language be learned in a subject-matter which is labelled as *non-linguistic*? Gajo (2007b) highlights:

⁴ In this study the term *second language* will be used henceforth to refer to both *second* and *foreign* language teaching and learning.

Il s'agirait de s'interroger sur la pertinence de la désignation « discipline non linguistique » [DNL], peu adéquate aux enjeux recherchés par l'enseignement bilingue. L'expression de DNL comporte d'évidents avantages pratiques, mais résiste à une conceptualisation sérieuse (paragraphe 10, lines 6-8).

Therefore, to avoid employing the arguable term, this study follows Dalton-Puffer (2007), Escobar Urmeneta (2011) and Eurydice (2005) who present successful alternatives both to '*discipline non linguistique*' and '*discipline dite non linguistique*' (Gajo, 2007b) and will use hereafter the term 'content subject' (Escobar Urmeneta, 2011).

Relating the account of the student's experience which opens this chapter to CLIL classrooms, it may be suggested that the *opacity* of the target language and therefore the potential difficulties set to learners (and often also to the teachers themselves) by the L2 become immediately apparent to teachers (see section 2.7.3). It may also be assumed that this newly gained awareness leads to substantial pedagogical and linguistic adjustments or *scaffolding* in the way teachers plan and discursively enact their lessons (see section 2.4), which may lead to a thorough revision of their often traditional pedagogical approaches and conversational strategies. This in turn may eventually promote not only the acquisition of the target language, but also a better comprehension of the subject-specific content under discussion in the lesson (Escobar Urmeneta, 2009, 2011; Gajo, 2007).

A number of studies have proved the above mentioned assumptions to be right at the level of curriculum adaptation, lesson plan and materials design. Thus, consistent patterns were observed in different teachers, subjects and schools (e.g., Canet Pladevall and Evnitskaya, 2011; Corredera, 2008; Escobar Urmeneta, accepted; Labajos Miguel and Martin Rojo, 2011; Llinares and Whittaker, 2009; see also contributions in Evnitskaya, 2011). Other studies have explored the learner-learner interaction that occurs as a result of a more learner-centred approach (e.g., Dooly and Moore, 2009; Escobar Urmeneta, in progress; Escobar Urmeneta and Jiménez Jiménez, in progress; Escobar Urmeneta and Nussbaum, 2008; Evnitskaya and Aceros, 2008; Horrillo Godino, 2009; Moore and Nussbaum, 2011; Moore, Nussbaum and Borràs, 2012; Simon Auerbach, 2012). A third set of studies have

focused on teacher-student interaction (e.g., Escobar Urmeneta and Evnitskaya, 2011, forthcoming; Evnitskaya and Morton, 2011; Jiménez Jiménez, 2010; Morton, 2012) in CLIL classrooms, which reveal in one way or another the teacher's awareness of the difficulties posed by the target language and her efforts to help students overcome them by adapting to the specific demands that emerge in the course of the lesson.

The given study intends to move forward on this line and show how CLIL contexts favour the emergence and co-construction by teachers and students of dialogic explanations whose foci sway from language to subject-matter content and vice versa helping students to gain a better understanding of the issues under debate and the means used to talk about them.

1.5. RESEARCH BACKGROUND

This study is part of a larger R+D+i project *Academic Discourse in a Foreign Language: Learning and Assessment of Science Content in the Multilingual CLIL Classroom (DALE-APECS*, reference EDU2010-15783), funded by the Spanish Ministry of Science and Innovation. It is a multidisciplinary research project carried out by (a) experts in language education from the CLIL-SI collaborative research team⁵ (*Content and Language Integrated Learning-Semi-Immersion*) and the GREIP consolidated research group⁶ (*Grup d'estudis d'Interacció Plurilingüe i Aprenentatge*), (b) experts in science education from the LIEC research group⁷ (*Llenguatge i Educació Científica*), both at the Universitat Autònoma de Barcelona (UAB), and (c) experts in language education from the Universidad de Almería.

The DALE-APECS research project seeks to gain understanding of how the integrated acquisition of scientific and communicative competences in a foreign language is instantiated in interaction in CLIL classrooms in which science is taught and learned in English as a foreign language. The abundant studies

⁵ <https://www.greip.uab.cat/>

⁶ <http://grupsderecerca.uab.cat/clisi/>

⁷ <http://grupsderecerca.uab.cat/liec/>

conducted on the CLIL approach and published over the last few years in Europe tend to focus either on language learning or content subject learning, thereby making integration the greatest challenge for current research on pedagogical proposals concerning CLIL.

The ultimate goal of the DALE-APECS project is hence to identify the characteristics of integrative instances and those of the contexts which foster their occurrence. Such characterization of instances of successful integration is considered vital for the determination of indicators of quality practice in CLIL settings, the construction of a theoretical model of teaching and evaluation practices, and the subsequent production of evaluation instruments specifically adapted to the distinctive communicative characteristics of CLIL environments. It is also expected that the outcomes of this work will render valuable information to inform classroom practice, teacher education programmes and educational policies regarding the generalization of active plurilingualism.

Taking the form of multiple case-studies, the project is interested in the detailed exploration of empirical data that come from three educational levels, namely, primary, secondary, and tertiary CLIL classrooms. In this regard, each case-study within the project is aimed to add a distinct integrative, ecological and holistic view on the Teaching-Learning-Assessment process in CLIL classrooms, whereas it is supposed that discursive patterns existing in such different contexts will indicate certain regularities in the way integration is enacted and achieved in teacher-fronted or small group-work interactions and in classroom-based assessment.

1.6. DISSERTATION OVERVIEW, ITS OBJECTIVES AND STRUCTURE

Carried out within the framework of the DALE-APECS research project, this dissertation is one of its multiple case-studies. Through the exploration of teacher-student interaction in one secondary CLIL science classroom in English as a foreign language, it aims to achieve the following overall objective of the project:

1. *To identify and characterize the conversational instances which provide evidence of the integrated acquisition of scientific competence and communicative competence in the target language in CLIL science contexts.*

More specifically, the study aims to explore and provide a detailed description of discursive traits of instances of language and academic content integration in one type of teaching-learning activity in CLIL science classrooms, namely, *the joint construction of academic dialogic explanations in the target language*. Here, *dialogic* is understood as distributed among several participants in interaction (Dalton-Puffer, 2007). The process of co-constructing such explanations by the teacher and the students is regarded as ‘conversational instances’ which can evidence the integrated process of teaching and learning of scientific competence of talking science and communicative competence of accomplishing it in the L2. In this way the study is expected to shed light on the way the interactional space co-constructed at each moment throughout the CLIL lessons encourage students’ active and significant participation in the joint elaboration of scientific knowledge in the target language in inclusive educational environments.

Drawing on such contextualization of the overall goal and through a recursive process of a data-driven research illuminated by pertinent theoretical models (see chapter 2), four more specific objectives were identified. Three of these objectives have given rise to three differentiated studies, each study still being tightly related to the other two. Meanwhile, the fourth objective was dealt with transversally in all three studies.

Study 1: Interweaving objects, gestures, and talk in the co-construction of dialogic explanations in the CLIL science classroom (chapter 4)

Specific objective 1: *To explore and describe the multimodal mediating process through which the participants, that is, the teacher and the students in the studied CLIL science classroom, jointly construct, negotiate and develop*

*contextually appropriate shared understandings within their CLIL science classroom community of practice*⁸.

Research question 1: How do the participants use material objects, gestures and talk to interactively mediate the co-construction of dialogic explanations and what are the outcomes of their negotiation in terms of language and content learning?

Study 2: 'What does *harmful* mean?' Cooperatively tackling opacity and density in the process of co-constructing dialogic explanations in the CLIL science classroom (chapter 5)

Specific objective 2: *To explore and characterize the process through which the participants signal and jointly tackle linguistic opacity and content density in the process of elaborating dialogic explanations in the CLIL classroom.*

Research question 2: What interactional resources do the participants employ to signal and tackle cooperatively linguistic and conceptual obstacles caused by L2 opacity and subject-matter content density?

Study 3: Does being 'silent' mean non-participation in the CLIL science classroom interaction? (chapter 6)

Specific objective 3: *To identify and describe traits of interactional competence in the L2, if any, displayed by those students who remain silent in the on-going process of the co-construction of dialogic explanations in the CLIL science classroom.*

Research question 3: What are the varied ways of participating in the interactional accomplishment of the joint elaboration of dialogic explanations of the so called 'silent' students'? What multimodal resources do such students mobilize in order to achieve their interactional goals, that

⁸ Communities of Practice approach to learning will be discussed in section 2.3.

is, to display their gains in the understanding of key aspects of the subject-specific knowledge being co-constructed in the L2 and/or make their contributions to that joint process?

Specific objective 4: *To identify and portray components of the teacher's classroom interactional competence which she deploys for the joint construction of dialogic explanations in the CLIL classroom.*

Research question 4: What multimodal scaffolding procedures does the teacher employ to guide students in the joint construction of dialogic explanations?

The four specific objectives stated for this dissertation can be summed up as the following:

Objective 1 = *Multimodal resources*

Objective 2 = *Opacity and density*

Objective 3 = *Silent participation*

Objective 4 = *CIC and scaffolding procedures across data*

Following the introductory chapter, the rest of the dissertation is structured into six chapters. Chapter 2 presents the main tenets of current sociocultural perspectives on teaching and learning which have been chosen as the theoretical framework of reference. Chapter 3 provides details on the design of research, the analytical tools employed in the study, the data corpus and participants, as well as the procedures followed in the treatment and selection of data to be examined in analytical chapters. Chapters 4 to 6 carry out a close examination of classroom interaction in the studied CLIL science classroom. A final discussion on the main findings emerged from the data exploration as well as the concluding remarks,

implications for teaching and teacher education and suggestions for further research are presented in chapter 7.

1.7. CHAPTER SUMMARY

This introductory chapter was opened with an invitation to the reader to have a first glance at the topic of the dissertation. This was followed by a brief overview of the complex sociolinguistic settings in Catalonia and current research on CLIL approach in Europe. Then, the DALE-APECS research project within which the study is framed was presented. Finally, the objectives and research questions stated for the study and its structure were provided.

CHAPTER 2: SOCIOCULTURAL APPROACHES TO TEACHING AND LEARNING

2.1. CHAPTER OVERVIEW

This chapter presents the main tenets of current sociocultural perspectives on teaching and learning, the theoretical framework of reference in the given study. The chapter is structured into an introduction, six theoretical sections (2.2 to 2.7), each one containing several subsections, and a chapter summary (section 2.8).

Section 2.2 presents the main constructs of Vygotskian sociocultural theory of human learning and development. These are mediation, cultural tools and mediated action (section 2.2.1) and social interaction, the latter including the role of language, the process of concept formation and the notion of 'zone of proximal development' (section 2.2.2). Section 2.2.3 discusses implications of Vygotskian sociocultural theory for educational research.

The rest of the sections present a series of complementary constructs and perspectives originated in Vygotskian sociocultural theory and which form part of what is now known as (neo-Vygotskian) sociocultural approaches to teaching and learning which are also relevant for the study. The constructs and perspectives discussed in sections 2.3 to 2.7 are interrelated and overlapping in many aspects. At the same time, each construct and perspective illuminates a different aspect of the same phenomenon – the interactional co-construction of academic dialogic explanations in CLIL science classrooms – which happens to be the object of this dissertation. The researcher assumes that, if combined in appropriate ways, these constructs and perspectives may offer a rich, multi-level and multi-angle interpretative framework which allows a fine-grained analysis of the phenomenon.

In this fashion, section 2.3 is devoted to the conceptualization of Communities of Practice. Section 2.4 discusses teachers' scaffolding for the joint construction of academic knowledge and discourse. This includes: the notion of

scaffolding (section 2.4.1), two types of classroom discourse (section 2.4.2), interactional scaffolding in L1 content classrooms (section 2.4.3) and CLIL classrooms (section 2.4.4).

Section 2.5 presents a socio-interactionist perspective on Second Language Acquisition (SLA) and has the following parts: L2 students' interactional competence (section 2.5.1), situated classroom interactional competence (section 2.5.2), and students' participation in classroom interaction (section 2.5.3).

Section 2.6 provides a research review of current conceptualizations of the role of discourse and interaction in science classrooms. This section is divided into two smaller sections on science teaching and learning and interaction in L1 classrooms (section 2.6.1) and on the role of language and discourse in science education (section 2.6.2).

Finally, section 2.7 is focused on explanations, the phenomenon under examination in this study. Hence, the discussion goes as following: explanations in L1 science classrooms (section 2.7.1), explanations in CLIL science classrooms (section 2.7.2), and linguistic opacity and content density in CLIL classrooms (section 2.7.3).

2.2. VYGOTSKIAN SOCIOCULTURAL THEORY OF HUMAN LEARNING AND DEVELOPMENT

Current sociocultural and socio-interactionist research approaches to (science and L2) education, which the present study heavily draws on, originate in the work of Vygotsky (1934, 1978, 1982, 1983). Vygotsky was a Russian psychologist who in the 1920s worked on the conceptualization of learning and human development. He particularly emphasized the relationship that exists between language and thought and between an individual and society (Mercer, 2000). Three fundamental themes can be identified in Vygotsky's writings: social origins of human mental development, the role of social interaction in this process and the primacy of cultural mediation.

The first theme is related to his claims about the *social origins* and social nature of higher mental functioning in individuals and is conceptualized in his 'general genetic law of cultural development' (Vygotsky, 1978). Vygotsky argued that human mental functioning can be understood only by examining in depth the social and cultural processes from which it derives as well as the developmental changes it has undergone: 'we need to concentrate not on the product of development but on the very process by which higher forms are established' (Vygotsky, 1978: 64-65).

The second theme concerns the role of *social interaction* in human development. Vygotsky considered that the individual's higher order cognitive functions and processes (e.g., intentional memory, voluntary attention, planning, rationality, perception and learning) are primarily regulated by and develop out of the individual's participation in socially mediated process (e.g., formal schooling) constituted by socially shared activities (Thorne, 2003). The process of individual cognitive development occurs through the mastery and 'internalization' of social and interactional processes (Wertsch and Tulviste, 1992). According to Vygotsky, it is evidenced in the fact that one's private thinking or 'inner speech' which enables the individuals to prepare and regulate their actions operates in a very similar way to how situated social interaction from which it derives functions (Lantolf and Thorne, 2006). These ideas are clearly expressed in the now well known citation from Vygotsky's writings:

Всякая функция в культурном развитии ребенка появляется на сцену дважды, в двух планах, сперва – социальном, потом – психологическом, сперва между людьми, как категория интерпсихическая, затем внутри ребенка как категория интрапсихическая (Vygotsky, 1983: 145)¹.

The last main theme in Vygotsky's work is the role of cultural *mediation* in the development of mind. He stated that 'the central fact about our psychology is

¹ 'Any function in the child's cultural development appears twice, or on two planes. First it appears on the social plane, and then on the psychological plane. First it appears between people as an interpsychological category, and then within the child as an intrapsychological category' (Vygotsky, 1981: 163).

the fact of mediation' (Vygotsky 1982: 166) arguing that human psychological processes are organized by three key cultural factors: activities, tools and concepts (Lantolf, 2006). According to Vygotsky, this means that human mental functioning, and any human activity in general (being it an individual or socially shared action), is socioculturally situated and mediated – or facilitated – by socially developed and organized *mediational tools* or means. These tools are social practices and artefacts (Wertsch, 1991) which are 'culturally constructed, historical in origin and social in content' (Scribner, 1990: 92). In short, Vygotsky suggested that social processes give rise to individual processes and that both are essentially mediated by tools.

Of the three themes in Vygotsky's theory of human development, the notions of mediation and social interaction are of especial relevance to research on the interactional co-construction of academic dialogic explanations in CLIL science classrooms. Therefore, in what follows a discussion of what Vygotsky understood by mediation (section 2.2.1) and social interaction (section 2.2.2) will be presented.

2.2.1. *Mediation, cultural tools and mediated action*

For Vygotsky, artefacts through which human action is mediated include two types of tools. The first one is *technical* or *material tools* which have a physical entity, such as writing utensils, laboratory instruments, books, clocks, wheels, machines, etc. The second type embraces *psychological tools*² or *signs*. These are semiotic modes of representation such as 'various systems for counting; mnemonic techniques; algebraic symbol systems; works of art; <...> schemes, diagrams, maps, and mechanical drawings; all sorts of conventional signs' (Vygotsky, 1981: 137). The most extensive and powerful of semiotic systems is undoubtedly language (Vygotsky, 1934), both in its written and spoken form. All signs are mediational devices which have been socioculturally developed. They are gradually appropriated by groups or individuals who actively engage – individually and together with other individuals ('social others') – into the sociocultural practices in

² Psychological tools are also often called *cultural tools* when they have gained certain value within human activities (see Lantolf and Thorne, 2006).

which these devices are used and thereby acquire relevant sociocultural experiences and find new meanings in their world (Wells, 2000; Yamagata-Lynch, 2010). Finally, *concepts* are the individuals' and collective understandings of different facets of the surrounding world such as personal, physical, social, cognitive, etc.

Figure 2.1 represents a simplified model of *mediated action* by which Vygotsky attempted to explain human development and learning as a mediated process in which individuals interact with mediational means and with other individuals within socially meaningful activities. Being used to explain both individual's learning and interpersonal communication, the model contains three elements: subject, mediating artefact, and object. The subject is the individual or group of individuals involved in the activity, the mediating artefact is physical objects, cognitive tools (e.g., language), individual's prior knowledge, social others, etc. which, acting as resources, contribute to the experiences of the subject. Finally, the object is the goal of the activity.

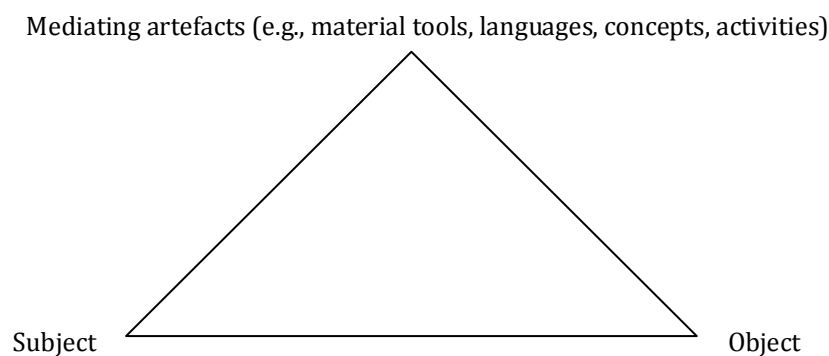


Figure 2.1. Vygotsky's basic mediated action triangle (Vygotsky, 1978: 40)

Being social in origin, material tools are externally oriented towards the object of the activity since, when being used, they mediate between the subjects (humans) and the objects (material world towards which the subjects' actions are oriented) and therefore help individuals to solve problems and shape the surrounding social milieu by producing changes in objects. Meanwhile, semiotically produced cultural tools serve to mediate one's own mental activity as they are internally oriented towards the subject of the activity thus allowing the individuals to cause changes in their physical and mental behaviour (Lantolf and

Appel, 1994). Hence, material and cultural tools not only serve as mediators in social human activities and individuals' cognitive functioning but they moreover fundamentally shape and transform the way the individuals interact with the social world as well as their very mental functioning (John-Steiner and Mahn, 1996). In turn, tools are also being transformed and new ones are being created through the very activities in which they are embedded (Hawkins, 2004).

Hence, on the one hand, the reciprocal interaction between social and cognitive activities mediated by cultural artefacts and social practices, the individual and the social milieu is conceived in the sociocultural theory as a dynamic and constantly changing process which involves an inherent tension and interrelationship between the three components of the mediated action (Wertsch and Tulviste, 1992), a key element in the process of human development and learning. On the other, what is of special importance in Vygotsky's conceptualization of this process is his assumption that individuals are not passive participants who wait for the milieu to engage them into meaning making processes. Rather, through their interaction with the mediating means and their own and others' concepts about themselves, the others and the world, individuals make sense of the surrounding reality while carrying out on-going activities and creating new ones that transform artefacts, concepts and social others in their environment (Yamagata-Lynch, 2010). These ideas of humans being so wedded to and constituted by artefacts and tools that they cannot be understood without them (Wells and Claxton, 2002) are perfectly captured by Wertsch (1998: 485) who described humans not as autonomous thinkers and solitary actors but rather as 'agents-acting-with-mediational-means'.

Let us now turn to the second theme in Vygotsky's work, namely, social interaction, in order to introduce another set of key theoretical constructs of the given PhD dissertation. In next section, Vygotsky's views on the role of language in human development and learning, the process of concept formation as well as his notion of 'zone of proximal development (ZPD)' will be examined.

2.2.2. *Social interaction: the role of language, concept formation and ZPD*

Vygotsky considered language '*the most sophisticated mediational mechanism in human sociocultural history*' (Ahmed, 1994: 158, italics added) and 'the root of learning, rather than a by-product of intellectual development' (Gibbons, 2006: 23). In Vygotsky's view, it has two main functions for individuals. On the one hand, language usually serves as a mediator of social activity as it allows individuals to plan, coordinate and review their actions. Moreover, it is used as a cultural tool in social interaction to 'share and jointly develop the knowledge – the 'culture' – which enables organized human social life to exist and continue' (Mercer, 2000: 10) by communicating, establishing social contact and influencing surrounding individuals (Vygotsky, 1934). On the other, it is used as a psychological tool in order to carry out such mental activities as thinking, reasoning, planning or reviewing one's actions (Lantolf and Thorne, 2006).

Still, the two functions of language are inherently integrated and interrelated since 'language links individual thought with collective resources of knowledge and procedures for getting things done' (Mercer, 2000: 15). Therefore, language is a principal mediating tool for *interthinking* or *thinking together* (Mercer, 2000), for jointly constructing knowledge, for making sense of individual's and shared experiences, for solving problems, for interacting with others about the surrounding world which is both physical and cultural, meaningful and significant (Edwards and Mercer, 1987), and so forth. So, the fact of using language to mediate these collective processes allows individuals to make sense of what is going on and what is being communicated and 'the words used in the social exchanges provide the very tools needed for individual thinking' (Mortimer and Scott, 2003: 3). All this allows learning and development to occur and accords language a central place in these processes.

Being applied to language learning, such Vygotsky's views have significantly influenced current sociocultural research on SLA that calls for the necessity to give special emphasis to 'conceptualizing language learning as a developmental *process mediated by semiotic resources* appropriated by the classroom <...> [which] include

print material, the physical environment, gestures, and most notably, *classroom discourse*' (Donato, 2000: 45).

It has been mentioned above that Vygotsky's theoretical approach to human development was primarily built on his statement that individual's higher mental processes have their origins in social processes. Apart from the mediated action model discussed in the previous section, another contribution to such approach – highly relevant for the given study – is Vygotsky's account of concept formation (Vygotsky, 1934) in which he differentiated between *spontaneous* and *scientific* concepts.

'Spontaneous' or 'everyday' concepts are sets of information that are based on the individual's concrete experience and that have never been abstracted or connected to other related concepts (John-Steiner and Mahn, 1996). Spontaneous concepts are usually acquired in everyday activities and interactions without any explicit and systematic treatment on the part of the individual (Wertsch, 1991). Being especially interested in the development and learning of natural, that is, first, language by young children, Vygotsky explicitly acknowledged the role of adults in the process of development of such concepts by children arguing that the latter appropriate 'everyday' concepts first by hearing how adults use them and then by starting to use them by themselves.

On the contrary to spontaneous concepts, 'scientific' or 'academic' concepts are those that are based on particular academic semiotic activities such as e.g., making claims, hypotheses or arguments, which are learned through the means of explicit instruction (Wertsch, 1991). Being related to the essential aspects of any area of school knowledge, such concepts include tools, symbols, practices and norms of any academic discipline and are usually explicitly presented as an organized system of interrelated ideas (John-Steiner and Mahn, 1996). Scientific concepts are knowledge that has been previously agreed upon by a community (e.g., school, group of scientists or society in general) and that can be shared, articulated and evaluated as a common cultural product. In Vygotsky's view, the process of formation of scientific concepts results in 'the mastery of abstract forms of reasoning associated with the kinds of tasks found in formal schooling in which

linguistic units are abstracted from their communicative contexts and become objects of reflection' (Wertsch, 1991: 38).

Vygotsky put this line of argument further by suggesting that the two types of concepts are actually highly interdependent and interrelated. He argued that the dynamic *intertwining* of spontaneous and scientific concepts that occurs in social interactions and shared activities in which individuals (e.g., parents and children, teachers and students) engage greatly contributes to the emergence of more abstract understanding (John-Steiner, Wardekker and Mahn, 1998). The point of Vygotsky's claim was that academic concepts do not substitute everyday ones in the process of conceptual development. Rather – and here he successfully used the metaphor of growth to describe their interdependence and influence on each other – 'scientific concepts *grow downward* through spontaneous concepts, while spontaneous concepts *grow upward* through scientific concepts' (Renshaw and Brown, 2007: 533, italics added).

Another key construct in the sociocultural view of learning as a mediated process is Vygotsky's notion of the *zone of proximal development* (Vygotsky, 1935). The notion refers to the distance or 'cognitive gap' that exists between what the individuals can do unaided and what they can do in cooperation with a more skilled other. Or, in Vygotsky's own words, the ZPD is:

Зона ближайшего развития ребенка - это расстояние между уровнем его актуального развития, определяемого с помощью задач, решаемых самостоятельно, и уровнем возможного развития ребенка, определяемым с помощью задач, решаемых ребенком под руководством взрослых и в сотрудничестве с более умными его сотоварищами (Vygotsky, 1935: 42)³.

Vygotsky argued that a less capable participant (e.g., young child, language learner) – through joint participation and socially and culturally situated interactions with a more capable participant (e.g., adult such as parent or teacher, peer) – learns how to use material or cultural tools to achieve the established goal

³ 'The distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers' (Vygotsky 1978: 86).

of the on-going activity. Successful collaboration with the other participant helps the learner go beyond what they are currently able to achieve independently, enter new social practices, participate in activities in which new meanings and knowledge are constructed and learn new skills or new ways of using mediating tools, particularly language (Gibbons, 2006).

The learner's ZPD is thus co-constructed in interaction between the participants as they engage in a range of activities. However, to constitute 'a potential for learning' (Wells, 1999) there need to be an appropriate amount of guidance or 'assistance'⁴ provided and a demand stated by the activity is to correspond to the learner (Lantolf, 2000).

The ZPD is an 'artefact-saturated medium' (Lantolf and Thorne, 2006) in which social forms of mediation develop through interaction with social others and the milieu (Rogoff, 1990) so that 'the child can reach higher or more abstract ground from which to reflect, ground on which he is enabled to be more conscious' (Bruner, 1985: 24). Drawing on the assumption that the individual's development is an *apprenticeship in collective thinking* (Mercer, 2000, 2002, 2004), a guided process of induction into new ways of meaning and thinking mainly through dialoguing and solving problems with others in the context of jointly undertaken activities, human development is thus a dynamic and interactively mediated learning process, and this process is intrinsically social and educational (Mercer, Dawes, Wegerif and Sams, 2004).

There is therefore a number of theoretical and pedagogical implications of the notion of the ZPD for educational practices. In concern to the theoretical importance of the notion, we would like to make two points. First, it encourages for a reconceptualization of a traditional understanding of *teaching* and *learning* as two separate – and often parallel – processes. The ZPD allows us to see what occurs in classrooms as *teaching-and-learning* (Mercer, 2002): a *single*, essentially *social* and *interactional* endeavour which unfolds *between* individuals within socially and culturally constructed world and in which language is used as a main

⁴ See section 2.4 for a discussion on *scaffolding*.

mediating tool (Lantolf and Appel, 1994; Wells, 1999)⁵. And second, this construct brings to the foreground the idea that knowledge is not located in the individual mind (mainly the teachers'), nor owned privately by each person in isolation.

On the contrary, knowledge is constructed and meanings are made *between* rather than within individuals (Gibbons, 2003) in the process of teaching-and-learning. This process only emerges in the context of a *joint social activity* through *guided collaborative interaction* with more knowledgeable others, that is, more experienced members of the culture (Wells, 2000).

In respect to the pedagogical significance of the notion of the ZPD, there are three issues noteworthy to be pointed out. First, as Vygotsky himself stated, the notion 'enables us to propound a new formula, namely that *the only 'good learning' is that which is in advance of development*' (Vygotsky, 1978: 89, italics added), that is, that learning through participation actually precedes and shapes development. Therefore, the process of teaching-and-learning at school should be organized in such a way that it always draws on the level of potential development of students thus dealing with what is just above their current competences and knowledge level.

Second, the notion implies that a teacher should not be merely the provider of knowledge to a group of individual students with (slightly or quite) different levels of competence and knowledge or the facilitator of their learning (Mercer, 2002) but rather 'the creator of a particular quality of intermental environment <...> in which students can take *active and reflective roles* in the development of their own understanding' (ibid: 145, italics added). And third, as there should be a joint activity carried out interactionally between students and teachers, the notion hence embraces both parties: a student's achievement and development 'can never be seen as solely the result of their innate ability, but as <...> success of the interaction between teacher and student' (Gibbons, 2006: 27).

⁵ Mercer's hyphenated spelling *teaching-and-learning* will be used henceforth throughout the dissertation to reflect our accordance with such stance.

2.2.3. *Vygotskian sociocultural theory of human learning and development: Implications for educational research*

Though Vygotsky's work was focused on the examination of the processes of L1 acquisition mainly in informal settings, his theoretical tenets have been highly influential in research on L2 education (e.g., Gibbons, 2006; Lantolf, 2000; Lantolf and Thorne, 2006; Seedhouse, 2004; van Lier, 1988, 2004; Walsh, 2006) as well as on educational research in general (e.g., Edwards and Westgate, 1994; Mercer, 1995, 2000; Wells, 2007). Thus, in the field of SLA an increasing number of neo-Vygotskian theorists and researchers (e.g., John-Steiner and Mahn, 1996; Lantolf, 2006; Mondada and Pekarek Doehler, 2004; see also contributions in Kramsch, 2002 and Lantolf and Appel, 1994) have challenged mainstream psychological and cognitively-oriented approaches to L2 learning that claim that the phenomenon is essentially an individual activity which forms part of the learner's autonomous cognitive development (see section 2.5).

In the field of L1 science education Vygotsky's premises that social interaction is fundamental and highly necessary for learning and not merely ancillary (Lemke, 2001) – since it is through guided conversations with others, in which individuals negotiate meanings and jointly construct knowledge and social practices they participate in, that most of learning and development occur (Wells, 1999) – have considerably contributed to fostering sociocultural views on science teaching-and-learning as 'a second socialization or specialist *enculturation* into a sub-community' (Lemke, 2001: 298, italics added; see also Ford, 2008) and its specific discourse⁶.

Following Vygotsky's understanding of learning as socially mediated, situated and publicly displayed process (van Compernelle, 2010), current sociocultural approaches to teaching-and-learning highlight the dynamic interdependence of social and individual processes in the co-construction of knowledge. In such a way they have succeeded in dissolving the Cartesian

⁶ See section 2.6 for a discussion on the conceptualizations of the role of discourse and interaction in science education.

dichotomy between the external and the internal (John-Steiner and Mahn, 1996). They also acknowledge teachers and students as active participants or *agents* in situated learning activities in which mediating (material and cultural) tools, particularly language, play a crucial role (Mercer, 2000). In the same line, such educational approaches increasingly conceptualize learning as *distributed* (Cole and Engeström, 1993), *interactive* (Lantolf, 2000) and *contextual* (van Lier, 2004) as well as the result of the *learners' participation in a community of practice* (Rogoff, 1990, 2003).

As a consequence of such perspective on learning, current socioculturally-oriented research calls for the necessity to consider 'the possibility that educational success and failure may be explained by the quality of educational dialogue, rather than simply in terms of the capability of individual students or the skill of their teachers' (Mercer, 2004: 139; see also Escobar Urmeneta, accepted; Escobar Urmeneta and Evnitskaya, 2011, forthcoming). It is therefore of vital importance to study the teaching-and-learning process in the classroom through the detailed examination of social interactions between teachers and students (Gibbons, 2006).

Applying these claims to the CLIL classroom – the educational context analyzed in the present study – Escobar Urmeneta and Evnitskaya (forthcoming) argue that it is the job of the CLIL teacher to interpret and respond appropriately to students' emerging contributions as well as to project them at more advanced levels of development within the students' ZPD. All this is to be done while offering students all the necessary (but temporary) support to guide their actions in the interactional space co-constructed at each moment throughout the lessons. Only after a number of experiences of supported participation in meaningful interactional social practices in the ZPD, the CLIL student will be able to carry out those actions on their own, independently from the CLIL teacher.

Hence, the sociocultural perspective may provide a relevant, comprehensive and solid theoretical framework necessary for a thorough examination of the process of teaching-and-learning that takes place in CLIL settings. The sociocultural constructs presented in the previous sections – primarily *mediation*,

social interaction and *the ZPD* – render thus particularly significant for the analysis of the object of study in the given dissertation, namely, the process of collaborative and interactional co-construction of academic explanations in the CLIL science classroom. Meanwhile, the construct of *mediated action* (and the related notion of *mediating artefacts*) is of special relevance for the detailed analysis of the way the teacher and the students in the observed CLIL classroom use material objects, gestures and talk to mediate this process which will be undertaken in chapter 4.

In the following section one of recent Neo-Vygotskian socioculturally-oriented perspectives on learning known as *Community of Practice approach* and highly pertinent for the given study will be presented.

2.3. COMMUNITIES OF PRACTICE AND SITUATED LEARNING APPROACH

Drawing from the Vygotskian sociocultural theory, in which social situations and co-participation are viewed as essential for learning, Lave and Wenger (1991) proposed and Wenger (1998) developed, a *Community of Practice* (CoP) approach to learning. The concept of CoP refers to people who share certain goals and interests and who become engaged in joint activities in order to achieve these goals. To be actually considered a community of practice, its members should develop a range of *shared social practices* (Wenger, 1998): ways of doing things and talking about them, as well as values, beliefs, and a common repertoire of resources (tools, routines, artefacts, vocabulary, symbols, etc.), the latter in some way carrying the accumulated knowledge of the community.

On studying different communities of practice in informal settings (e.g., Yucatec midwives, Vai and Gola tailors, and the apprenticeship of butchers), Lave and Wenger argue that such professional CoPs can also be considered ‘learning communities’⁷ (Bielaczyc and Collins, 1999). This is possible because the very participation of newcomers and old-timers in the process of joint construction of knowledge within shared social and cultural practices is seen as collective

⁷ Learning community is a community which explicitly reflects ‘culture of learning in which everyone is involved in a collective effort of understanding’ (Bielaczyc and Collins, 1999: 271).

learning. Hence, when newcomers join an already existing CoP, they do not acquire abstract knowledge to be later applied to 'real' contexts, but are rather guided by old-timers (or experts) in their apprenticeship: a two-fold process of learning about the social practices of the community and of concurrently developing abilities to perform such practices appropriately through an increasing participation in them.

However, this gradual movement from initially limited or *legitimate peripheral participation* to *full participation* in the co-construction of knowledge and membership as active practitioners (Lave, 1988; Rogoff, 1990) to be validated within the CoP should be mutually recognized by both novices and experts. Finally, such *situated learning* (Lave and Wenger, 1991) is tightly related to identity formation since it is precisely through social participation in the CoP that newcomers progressively construct relevant identities as competent members of the community.

Such conceptualization of the learning process as *social accomplishment* clearly confirms its origins in Vygotskian sociocultural theory as it represents a firm shift from a cognitively-oriented individualistic to social perspective. 'Learning is viewed as distributed among many participants within the community in which people with diverse expertise <...> are transformed through their own actions and those of other participants' (Buysse, Sparkman and Wesley, 2003: 266).

For Lave and Wenger (1991), situated learning and identity formation in CoPs occur through constant *negotiation of meaning* which is conceptualized as a dynamic and dialectic interrelation between two processes: participation and reification. *Participation* refers to the process of learning through active engagement in the socially embedded practices of a community and through the construction of a relevant identity. This means that participation gradually shapes what new members do and who they are, as well as how they interpret what they do and who they are. *Reification* refers to the process by which certain meanings become, as Wenger puts it, 'congealed' as abstract concepts, documents, labels, categories, etc. (Wenger, 1998). Neither participation nor reification on its own can

provide a full account of how CoPs are brought into being and maintained. By focusing on patterns of participation alone, we leave out the concepts, labels, and terms which have been produced by the community over its existence. By focusing on reification alone, we create a static image of 'frozen' meanings and their linguistic representations which cannot explain how they are used in interaction.

According to Wenger (1998), then, for any group of people to be considered a CoP and their joint social practices to generate coherence within the community, the three criteria of mutual engagement, a shared repertoire of resources for the negotiation of meaning accumulated over time and the pursuit of a joint negotiated enterprise must be met. However, in the educational context, for some researchers it is questionable whether a teacher and students in a classroom can be considered a CoP. This may be due to a traditionally hierarchical and asymmetric distribution of power, roles and identities in classrooms, or to the fact that teachers and students may not share joint goals (Haneda, 2006). On the other hand, Hellermann (2008) considers the classrooms of adult learners of English as L2 in his study to constitute a CoP in light of the fact that they attend class voluntarily and share similar goals related to the utility of learning English for social integration. As the author states, 'learning <...> occurs through the social interaction of a number of individuals who come together as a collective, mutually goal-oriented enterprise' (Hellermann, 2008: 2).

The line of argument put further here is not that researchers are to adopt the position that *any* classroom is a CoP, but rather that a classroom *may* take on characteristics of such a community through the coordinated actions of its members who actively contribute to the classroom social practices. It is assumed therefore that classroom practices such as, for example, the teacher's brief exposition to (and hence sharing with) students of teaching-and-learning goals for the lesson at the beginning of each lesson, the processes of setting such goals or planning classroom activities together with them or the collaborative development of assessment criteria do allow considering a certain classroom a CoP.

Turning to science classrooms, these can be seen as CoPs and the learning of school-science as 'situated learning' if students are provided opportunities for the

participation in 'the social and symbolic worlds' (Kelly, 2007: 443) of their science classrooms through contextualized, meaningful and relevant classroom activities (Kelly and Chen, 1999). As well as if they are given access to academic knowledge through which relevant subject-specific reifications are co-constructed and shared understandings of such reifications are developed (Edwards and Mercer, 1987). As Wells (1999: 108) argues, 'understanding comes into existence through participation in a particular activity; <...> by contributing to joint meaning making with and for others, one also makes meaning for oneself and, in the process, extends one's own understanding'.

While Wenger (1998) does not see participation in CoPs as primarily a discursive activity, this study follows current trends in science education which claim that school-science and its social classroom practices consolidate a CoP with its own specific language which students need understand and use appropriately and flexibly in order to become active members of this community (see section 2.6). In this line, Lemke (1990) compares the learning of this specific language of school-science, which too often turns out to be a new linguistic code for students, to the learning of a foreign language (FL). That is, that in order to master both of them students need to learn to *translate* meanings from one 'system of expression' (be it everyday language or the L1) to the other (be it academic language of school-science or a FL) and vice versa. In such a way science education enables students to become 'fluent speakers of science' (Lemke: 1990).

Taking this metaphor one step forward and applying Lave and Wenger's insights to the context of CLIL science classrooms, the notions of community of practice and situated learning result even more relevant as students are actually required to learn concurrently *two* 'foreign' languages (see e.g., Laplante, 2000, 2004). They need to speak the language of school-science with its highly conceptual and abstract concepts as the community of 'science talkers' talks it and simultaneously use the L2 (English) through which school-science is taught as the community of English speakers uses it. In a teaching-and-learning environment in which the working language is not the students' (and often the teachers') L1 but rather a language in which they have a developing communicative competence it is a pertinent educational goal to afford students opportunities to participate in CLIL

classrooms' legitimate social practices of rediscovering and reconstructing appropriate academic knowledge through their own active pursuit, efforts and inquiry in order to co-construct understandings of such classroom experiences. And to carry it all out interactionally through the joint construction and use of L2 academic discourse.

It should be noted here that despite its relevance and utility for the understanding of the process of teaching-and-learning taking place in classrooms Lave and Wenger's construct of CoP has been criticized for its failure to theorize about language in use. As Creese (2005: 55) points out, 'despite its emphasis on negotiation of meaning, we are given little insight into how meanings are made and interpreted. It [i.e., the construct of CoP] lacks infrastructure to explain the role language plays in social life'.

In an attempt to overcome this drawback, Creese (2005) combines the CoP approach with ethnography of communication, namely, with the notion of 'speech communities' (Gumperz, 1971). Her findings reveal how power relationships and conflicts are created and maintained in a high school through the process of privileging or silencing certain types of discourses. Tusting (2005) also argues for the necessity to develop a theoretical model of language as part of the social practices of participation and reification, the key practices within any CoP. With this aim she proposes to enrich the CoP theory with the insights from the critical social linguistics which strongly relates language to other elements of the social world.

In a recent study, Evnitskaya and Morton (2011) suggest that the analytical infrastructure that Creese (2005) and Tusting (2005) find lacking in the CoP approach can be afforded by the methods and insights developed in Conversation Analysis (CA). Evnitskaya and Morton combined the CoP approach to learning and CA analytical tools with the aim to explore and characterize talk and other semiotic resources with which CLIL teachers and students participate in their science classroom CoPs by negotiating meanings inherent to the practice and reifications through which it is construed. This dissertation goes further and in analytical

chapter 4 combines the CoP approach, CA analytical machinery (see section 3.3.1) and the sociocultural construct of ‘mediated action’ (section 2.2.1).

Let us now turn to another key construct in the socioculturally-oriented perspectives on learning and pertinent for the given study, more particularly, the notion of *scaffolding*. In next sections, first, operational definitions of the construct and current research on scaffolding in classroom contexts will be examined (section 2.4.1). These will be followed by a discussion of interactional scaffolding provided to students in L1 content classrooms and CLIL classrooms in the process of making meaning and co-constructing academic knowledge and discourse (sections 2.4.2 and 2.4.3, correspondingly).

2.4. SCAFFOLDING FOR THE JOINT CONSTRUCTION OF ACADEMIC KNOWLEDGE AND DISCOURSE

2.4.1. The notion of scaffolding

Originating in Vygotsky’s notion of the ZPD (section 2.2.2), the construct of *scaffolding* was initially proposed by Wood, Bruner and Ross (1976) for the description of tutoring strategies that parents employed when they interacted with their young children while helping them to solve certain activities. According to the authors, scaffolding implies the following six tutoring functions (Figure 2.2):

- 1) *Recruitment*, i.e. getting the problem solver’s interest in and adherence to the requirements of the task;
- 2) *Reduction in degrees of freedom*, i.e. simplifying the task by reducing the number of constituent acts required to reach solution;
- 3) *Direction maintenance*, i.e. keeping children in pursuit of a particular objective and maintaining direction by making it worthwhile for the child to risk a next step.
- 4) *Marking critical features*, i.e. highlighting certain relevant features of the task in order to provide information about the discrepancy between what has been produced by the child and a correct production;

5) *Frustration control*, i.e. following the maxim 'Problem solving should be less dangerous or stressful with a tutor than without' by using 'face saving' techniques or exploiting the learner's 'wish to please' the tutor, among others, and

6) *Demonstration*, i.e. showing or 'modelling' solutions to a task which involves an 'idealization' of the act to be performed to the degree to include sometimes the completion or explication of a solution already partially executed by the tutee.

Figure 2.2. Tutoring functions of scaffolding (Wood *et al.*, 1976: 98)

Two decades later, in his study on language learning in the L2 classroom, Donato (1994) adapted and simplified Wood *et al.*'s quite lengthy operational definition of the construct in order to make it more comprehensible and appropriate for the field of SLA. In his model, scaffolding entails a combination of the following six elements:

1. *Recruiting* interest in the task,
2. *Simplifying* the task,
3. *Maintaining* pursuit of the goal,
4. *Marking* critical features and discrepancies between what has been produced and the ideal solution,
5. *Controlling* frustration during problem solving, and
6. *Demonstrating* an idealized version of the act to be performed (Donato, 1994: 41).

Within the current sociocultural perspective, scaffolding refers to any type of expert-novice assisted performance, be it between parents and children in informal activities and games, masters and apprentices in trades or teachers and learners in formal schooling. Scaffolding embraces both the process of providing support and its amount offered by the expert or 'mediator' (e.g., parent, master, teacher, more capable peer) to the novice (e.g., child, apprentice, learner) within the ZPD of the latter. Both of these enable the novice to accomplish activities which would be otherwise beyond their grasp (Lantolf, 2000).

Therefore, by guiding and supporting novices through interaction in the frame of meaningful learning activities more knowledgeable others facilitate the novices' movement forward in their ZPD. This means that by engaging novices in guided interaction the expert helps them extend their current competences and

knowledge and progress in learning and understanding to higher levels of ability (Barnard and Campbell, 2005).

What is even more important in the notion of scaffolding is the fact that such assistance should be temporary. This implies that the expert is expected to continuously revise the scaffold 'in response to the emerging capabilities of the novice' (Donato, 1994; see also Rogoff, 1990). As the abilities of the latter increase, the expert progressively withdraws the amount and type of individualized support provided until the novice is able to complete the activity unaided. The ultimate goal of the expert when using such mediating 'scaffolded help' is therefore to empower the novice with the necessary abilities and knowledge and to help them become an independent and self-regulating learner and problem solver (Edwards and Mercer, 1987)⁸. Finally, in sociocultural approaches to teaching-and-learning scaffolding is conceived as an essentially collaborative process in which actions, meanings and understandings are negotiated and constructed together through guided interaction, 'the fundamental medium within which learning takes place' (Erickson, 2006: 181).

Bearing in mind such conceptualizations of the notion of scaffolding, it may be argued hence that there are clear similarities between the latter and the key concepts of the CoP approach to learning discussed in the previous section.

Turning to research on teaching-and-learning in classroom context, the metaphor of scaffolding has been quickly adopted and widely used to identify and characterize pedagogical adjustments proper of such expert-novice assisted performance⁹ (e.g., Brooks, 1992; Cazden, 1988; Mercer, 1995; Poehner and

⁸ Such understanding of the scaffolding process clearly reveals a 'dynamic' nature of the notion and in no way underlies an observable tendency to overuse the notion in the educational field, namely, in its indiscriminate and unjustified application to, for example, the process of designing teaching materials which results in a significant simplification of highly cognitively and linguistically demanding academic activities in certain school disciplines.

⁹ Donato (1994) proposed the notion of 'collective scaffolding', which refers to interactional support mutually offered by students in L2 classrooms while carrying out pair/small group activities, in order to show that L2 learners can mutually assist and scaffold each other in the same way as experts scaffold novices.

Lantolf, 2005; Wells, 1999) 'which involves not simply helping to do but helping to know how to do' (Gibbons, 2003: 249). It is argued that the collective process of teaching-and-learning is mainly mediated by teachers' rich, explicit and temporary – however essential – assistance which aims at helping apprentice learners to develop their linguistic and academic competences, acquire and enrich their linguistic and semiotic resources as well as achieve higher levels of understanding of curricular knowledge (Gibbons, 2008; Mercer, 1995; Mortimer and Scott, 2003). Being active participants in classroom interaction and socially situated shared practices of their classroom CoP, both parties collaborate in the co-construction of new knowledge and comprehension of this new shared *common knowledge* (Edwards and Mercer, 1987; Mercer, 2000). They also work together on the students' appropriation of school academic discourse necessary for meaning making in classrooms (Gibbons, 2003; Lemke, 1990).

The following section will be devoted to the discussion of the role that language and discourse play in the process of teaching-and-learning in classrooms.

2.4.2. *Two classroom discourses: everyday vs. academic*

Students bring into classrooms *informal* ways of speaking about the world around them based on their everyday experiences as well as on their own judgment and concerns. Such *everyday discourse* (Mercer, 1995) is characterized by the use of 'common sense' knowledge and popularly accepted ideas which students can find, for example, in conversations with their friends and family, social encounters with other people, TV, Internet, etc. and other non-academic settings.

Very different to everyday discourse is *academic* or *educated discourse* (e.g., Cummins, 2000; Gibbons, 2006; Mercer, 1995; Mohan, 1986), one of numerous *social languages* (Bakhtin, 1981) which throughout the human history were developed, accepted and used for specific purposes by 'a specific stratum of society <...> within a given social system at a given time' (Bakhtin, 1981: 430). Such social languages are 'permeated with concrete value judgments; they knit together with specific objects, <...> belief systems <...> and points of view peculiar to particular professions' (Bakhtin, 1981: 289). So, in case of academic discourse, it is the

outcome of work produced by scholars and researchers in each academic discipline at some point in time and space in the process of constructing the corresponding field of knowledge, carrying out research and disseminating results (Sanmartí, 2003). Educated discourse is mainly characterized by its *de-contextualized* nature: 'words are dealt with free of context, in terms of abstract meanings' (Mercer, 1995: 106-107), as well as by its tenets of precise focus, analyticity and criticism (Pujol, 2003).

Moreover, as there are many different academic disciplines (e.g., history, science or music) there is no unique and universal academic discourse related to universal knowledge, but rather as many educated discourses with their particular forms of reasoning as there are fields of discipline knowledge (Lemke, 1990; Sánchez Gómez and Martín, 2003). Additional issue comes to the foreground when we turn to the educational context in which such specific knowledge of each discipline is to be taught. According to Chevallard (1985), what is taught as subject-matter content is fundamentally different from what results from research in the disciplinary field. Chevallard argues that through the process of pedagogical transposition (*transposition didactique* in French original) highly conceptual *savoir savant* of scholars and scientists is pedagogically transformed into educational *savoir enseigné* that forms part of (school) syllabus and textbooks.

Many researchers argue that actually the discourse of any academic discipline needs to undergo the process of pedagogical transposition in order to be taught (for research on history discourse and its teaching at school see e.g., Casas, Bosch and González, 2005; Plá Pérez, 2008 and Santisteban and Pagés, 2006; on music discourse and its teaching see e.g., Viladot, Gómez and Malagarriga, 2010). In case of science, for example, academic discourse employed by scientists is pedagogically transformed into (school) scientific discourse (Renshaw and Brown, 2007; Wiser and Amin, 2001), which for the sake of comprehension and in order to be clearly distinguished from the former will be called *school-science discourse* and used henceforth in the given study. In classrooms, be these in the L1 or the L2, teachers and students use such discourse to (re)construct and communicate academic knowledge of school-science, its main achievements and its evolution throughout the time (Sanmartí, 2002). But they also recruit their 'everyday voice of

practical reasoning' (Renshaw and Brown, 2007) and informal talk as resources for teaching, learning and shaping knowledge and practices of school-science (Ballenger, 1997; Hicks, 1995).

Drawing upon Vygotsky's 'growing' metaphor of the interrelationship between everyday and scientific concepts (section 2.2.2), it can be argued then that teachers and students constantly engage in interactional processes of 'packing' and 'unpacking' knowledge (Gibbons, 2008; Lin and Man, 2009). On the one hand, they use their commonsense experiences, knowledge and ways of talking in order to teach-and-learn those of school-science and, on the other, they transform technical language and concepts into more everyday terms. Such *dynamic interweaving* between the two types of knowledge, discourses and underlying concepts allows teachers to offer students appropriate and necessary scaffolding in their learning process as well as helps students to deepen their understanding of subject-matter content and effectively participate in joint meaning making and academic knowledge co-construction.

Therefore, the construct of (pedagogical) scaffolding presented in section 2.4.1 renders particularly important for the detailed examination and characterization of the process by which meanings are negotiated in interaction and students and teacher's everyday views and ways of talking about the phenomena under consideration are progressively integrated and/or transformed into co-constructed subject-specific knowledge and discourse. So, let us now turn to the discussion of one type of scaffolding, namely, interactional scaffolding, and how it can be effectively provided by teachers in L1 content classrooms (section 2.4.3) and CLIL classrooms (section 2.4.4).

2.4.3. Interactional scaffolding in L1 content classrooms

From the sociocultural perspective on teaching-and-learning, content teachers can be considered experts in discourse-intensive social practices of their classroom CoPs which they carefully and effectively 'orchestrate' (Sohmer, Michaels, O'Connor and Resnick, 2009; Mortimer and Scott, 2003). Acting as 'discourse guides' (Mercer, 1995) they create learning-promoting situations by engaging

students in academic interactions within meaningful activities. Though problem solving, meaning making and the co-construction of specific academic knowledge, teachers also involve students in the process of scaffolding that progressively leads them to deeper levels of understanding of the surrounding world. In such a way teachers provoke the students' active engagement in the teaching-and-learning process and their gradual movement from the legitimate peripheral participation in classroom interaction to full participation as 'practitioners' and speakers of a certain content subject.

A great deal of educational research has demonstrated that teachers employ a rich toolkit of interactional scaffolding strategies to guide their students in the social process of the negotiation of meaning and the co-construction of knowledge, understanding and discourse. For example, Mercer (1995), drawing from research on teaching different types of content subjects in L1 environments, elaborated a classification of teaching interactional strategies (Figure 2.3): 'techniques' that serve to elicit students' previous knowledge, respond to their contributions and, finally, describe important elements of common classroom experiences.

- To elicit knowledge from learners:
 - Direct elicitations
 - Cued elicitations
- To respond to what learners say:
 - Confirmations
 - Rejections
 - Repetitions
 - Elaborations
 - Reformulations
- To describe significant aspects of shared experiences:
 - 'We' statements
 - Literal recaps
 - Reconstructive recaps

Figure 2.3. Some interactional techniques that teachers use (Mercer, 1995: 34)

Thus, according to Mercer, apart from providing information, checking students' understanding and maintaining control in the classroom, it is common for teachers to elicit previous and relevant knowledge that students have about the

studied topic, that is, detect what they know and understand, and make it *public* and shared by all participants. They usually accomplish it through open and meaningful questions, long pauses and indirect verbal or visual clues. Teachers also regularly reply to students' interventions in order to give them appropriate feedback, incorporate what they say into the on-going conversation, and gather their contributions to build more generalized or precise meanings, in such a way relating the students' already existing ideas and ways of thinking to new educational frames of meaning (see also Leach and Scott, 2003). To do this, they use confirmations, repetitions, elaborations and reformulations or, if needed, rejections. Ultimately, on suitable occasions, teachers describe significant moments of shared classroom experiences through 'we' statements and recaps to help students realize how different classroom activities they engage in contribute to their learning process or represent common knowledge and a joint understanding. Sometimes, teachers also employ recaps to preview what is to come in the lesson or directly set up a future activity.

Studies carried out particularly on teacher-student interaction in L1 science classrooms have identified a range of more concrete interactional scaffolding strategies that are frequently employed by science teachers. Among these the following can be mentioned: *using questions* for the promotion of critical thinking and reasoning (e.g., Chin, 2007; Mercer, 2008; Roth, 1996; van Zee *et al.*, 2001), *connecting everyday discourse to academic discourse* (Leach and Scott, 2003), *'modelling' educated ways of using language* (Crawford, 2000; Tobin, 2006; see also contributions in Fraser, Tobin and McRobbie, 2012), asking students to *provide evidence* for their reasoning and *prompting them for further participation* (Sohmer *et al.*, 2009).

In relation to the use of questions, Clegg (1987) and Chin (2007) identified and characterized various questioning approaches that teachers employed to stimulate productive thinking in students and guide them in the co-construction of school-science knowledge. Namely, teachers' questions were aimed to check on learning, review previously studied content, encourage students to generate ideas based on reasoning and their prior knowledge or search different or alternative

solutions to posed problems, as well as challenge students to reflect on critical issues from multiple perspectives or on values they had not previously considered.

In the same line, Mercer (2008) and Sanmartí (2002, 2003) argue that *good questions* – the ones that start with ‘why’ or even ‘why do you think...’, are based on students’ experiences and call for creative thinking – can effectively serve for guiding and developing students’ conceptual understanding of academic knowledge and favouring their participation in its joint construction. According to Márquez, Roca and Via (2003), *good questions* are those that are ‘productive’, that is, those that activate the construction of new shared knowledge, rather than those which require mere reproduction of memorized information; those that are meaningful, contextualized and appropriate for the students’ age; those that provide clues to how they are to be responded; as well as those that clearly state *what* they want to ask through the appropriate use of verbs such as ‘define’, ‘describe’, ‘explain’, ‘justify’, etc. related to cognitive-linguistic competences (Jorba, Gómez and Prat, 2000).

Classroom questioning practices that include such elements help teachers to afford students necessary scaffolding in relating the students’ own ideas to co-constructed shared academic knowledge, in school-science reasoning and in *doing* more than just ‘saying’ an answer, even if it is a correct answer. As Márquez, Roca and Via (2003: 29-30) state,

Les bones preguntes són imprescindibles per a una bona docència, de la mateixa manera que han estat sempre el desencadenant de les aportacions científiques rellevants en tots els camps del saber. <...> El que diferencia la ciència d’altres àrees és la manera de preguntar-se sobre els fets, la manera d’aproximar-se als fenòmens, és a dir la manera de ‘mirar’.

A series of case studies carried out by van Zee *et al.* (2001) show teachers creating comfortable discourse environments such as teacher-guided discussions and student-generated discussions in which students are encouraged to formulate insightful questions about science topics. Such findings evidence, on the one hand, the importance of establishing and maintaining contexts and conditions which promote students’ questions (see also e.g., Duschl and Osborne, 2002) and, on the other, the fact that by posing good and learning-advancing questions teachers

model how to construct 'healthy' questioning practices for students to make their own. Other researchers go even further by arguing that in supplying students with appropriate scaffolding (or even explicitly teaching them) in the elaboration of scientific ways of questioning addressed to others and themselves is actually teaching them to see surrounding reality in a scientific way and constitutes hence one of the essential elements of science education (Carlsen, 1991; Izquierdo and Sanmartí, 2003; Roth, 1996).

Another strategy often found in L1 science classrooms is that of connecting or *bridging* everyday discourse that students bring to the classroom with school-science discourse (Leach and Scott, 2003). By explicitly indicating similarities and differences between the two ways of talking about the same topics, teachers develop students' awareness of different discourses existing in the classroom and the ways these may support and enrich each other (Macbeth, 2000; Moje, Collazo, Carillo and Marx, 2001). Drawing on students' colloquial language and everyday experiences, needs and interests, teachers connect the ways these speak about scientific topics to formal and highly conceptualized subject-specific language and academic knowledge. By mediating students in their efforts to 'talk their way into science' (Gallas, 1995) through, for example, school-science explanations or claims, teachers gradually introduce students into ways of talking, thinking and acting (Radinsky, Oliva and Alamar, 2010; Yerrick, 2005) as competent school-science practitioners.

Teachers however are also expected to offer students an opportunity to see that 'the formal scientific style is not the whole of science. It is used for a few special purposes, mainly to summarize the results of what scientists do, but it does not reflect how science really gets done' (Lemke, 1990: 174). Hence, effective teachers are those who guide students in their learning to use academic discourse flexibly and thoughtfully, that is, learning to construct scientific knowledge in more than one way and according to the rules of school-science, rather than to 'simply parrot back the *words*' (Lemke, 1990: 91, original italics) or guess the correct answer that teachers have in their heads in order to 'say it right' (Ogborn, Kress, Martins and McGillicuddy, 1996). This means guiding students in using both

specific school-science reifications and their own informal wordings, which will obviously vary depending on the context and the needs of what is being developed.

Teachers are also seen to model in the classroom what scientists usually do (Crawford 2000; Tobin, 2006). Among these, the most relevant for the present study is teachers' modelling of the appropriate ways of 'thinking aloud' through educated ways of using language in the course of solving problems or developing arguments, explanations and claims (Jimenez-Aleixandre, Rodriguez and Duschl, 2000). It is noteworthy that in this way teachers model what can be called 'process discourse', that is, a series of overtly marked step-by-step conversational moves and techniques that lead to 'final discourse' (e.g., the solution of a problem, a complete explanation or a lab report). Acting as discourse mediators for students, teachers thus determine how academic knowledge is to be 'constructed, framed, portrayed, communicated, and assessed through language' (Kelly, 2007: 443) and explicitly guide students in their understanding of what counts as legitimate knowledge in the field of school-science (Osborne, Erduran and Simon, 2004).

Experts in science education highlight that academic discourse co-constructed in interaction in science classrooms tends to resemble much more the formal language of writing than everyday spoken language. This implies explicitly teaching by teachers and understanding and acquiring by students of 'ground rules' (Izquierdo and Sanmartí, 2003) of minor and major discourse genres of school-science (Lemke, 1990)¹⁰. The former include descriptions, comparisons, explanations, etc. while the latter embrace larger formats such as, for example, lab reports. It is argued that in those science classrooms in which teachers and students explicitly work on *how* such subject-specific genres are elaborated and students are given enough time, these latter display a deeper understanding of the

¹⁰ This is also true in other school content subjects. As Escobar Urmeneta (submitted) notes, students are required to acquire specific textual and discourse genres which are characteristic of each school area. For example, they need to learn how to describe a flower in the way it is done in botany which is different from a literary description, or how to make hypotheses in the way it is done in physics, or establish a cause-consequence relationship of an event in the way it is done in history (Gibbons, 2003; Horrillo Godino, 2011; Jorba, Gomez and Prat, 2000; Sanmartí, 2002).

way academic knowledge is constructed through discourse genres and participate more effectively in its elaboration (Duschl and Osborne, 2002).

Finally, in L1 science classrooms teachers also ask their students to provide evidence for their reasoning and incite them to participate actively in unfolding interaction. In this respect, it results pertinent to discuss the notion of 'Accountable Talk'¹¹. It was proposed by Michaels, O'Connor, Hall and Resnick (2002)¹² who catalogued key features of school academic discourse produced by both teachers and students in the classroom and common to any content subject (e.g., mathematics, science, history, literature) under the term *Accountable Talk*. According to the authors, it is talk that is accountable to *the learning community*, to *knowledge*, and to *rigorous thinking*.

In order for teachers and students to talk accountably to the learning community, they need to always attend to *what is said* in the classroom in regard to the issue under discussion and further develop the ideas of others in their own talk. To produce talk accountable to knowledge they are expected to apply relevant academic knowledge that is *publicly accessible to the group* (in our case, the science classroom CoP), make explicit use of the pieces of evidence behind one's claims, argumentations or explanations appropriate of a studied content subject (e.g., proofs in mathematics, data from investigations in science, textual references in literature, documentary sources in history) and follow norms of good reasoning established in each field of knowledge. Ultimately, to talk accountably to rigorous thinking, teachers and students need to establish certain *logical relationships* or connections (e.g., addition, sequence and space, causality, contrast, condition, illustration, specification) between subject-matter concepts, accepted academic knowledge and their own ideas as well as between these and the corresponding reasonable conclusions. In such a way 'Accountable Talk sharpens students'

¹¹ It is similar to what Mercer (1995) suggests as 'exploratory talk', however, in our opinion, more thoroughly developed.

¹² The presentation of the notion of Accountable Talk has been heavily drawn upon the account given in Sohmer *et al.* (2009), this due to the lack of access to the original source, that is, a CD-ROM set (Michaels *et al.*, 2002) published by the University of Pittsburgh.

thinking by reinforcing their ability to explicate, use and create knowledge' (Sohmer *et al.*, 2009: 106).

The concept of Accountable Talk may render highly useful and enriching for furthering our understanding of the process of interactional co-construction of dialogic explanations in the L2 in CLIL science classrooms – the object of the given study – as participation in social, cultural and discursive practices of the science classroom CoP. The use of Accountable Talk as an analytical construct for the exploration of interaction in CLIL science classrooms may allow CLIL researchers to identify and characterize interactional instances that evidence the following elements of the guided process of school-science teaching-and-learning: (a) joint construction of knowledge, (b) students' participation in the science classroom CoP, and (c) development of students' identities as school-science practitioners.

However, it should be noted that in regard to one of the components of the notion, namely, rigorous thinking, this study is not interested in the individuals' mental activities that occur in the process of teaching-and-learning *per se* but rather in the way these can be observed in interaction. The study follows therefore Mercer's (2004) view on interaction between teachers and students 'as a social mode of thinking' and proposes the term *rigorous academic discourse* to describe the social and interactional process of rigorous thinking about school-science topics through talking.

2.4.4. *Interactional scaffolding in CLIL classrooms*

A growing body of research on teacher-student interaction in CLIL classrooms brings evidence that such educational settings present many of the guiding strategies described in the previous section, namely, those identified by Mercer (1995) as well as good questioning practices and bridging strategies (e.g., Dalton-Puffer, 2007; Escobar Urmeneta and Evnitskaya, forthcoming; see also contributions in Escobar Urmeneta, 2009). However, scaffolding that teachers provide to their students is even more vital in classrooms in which the working language is the L2 for the majority of participants (in this study for both the

students and the teacher) due to a dual focus of the teaching-and-learning process that takes place there.

Recent studies on interaction in CLIL science classrooms carried out within the DALE-APECS research project (UAB) indicate that such contexts are particularly rich in the use of scaffolding procedures (Escobar Urmeneta and Evnitskaya, forthcoming; Simon Auerbach, 2012) as well as of multimodal semiotic resources and material objects to mediate the teaching-and-learning process (Borràs, Moore and Nussbaum, 2010; Evnitskaya and Morton, 2011; Moore, 2011). Other studies reveal a diversity of elicitation techniques employed by CLIL teachers, among which teachers' passing the responsibility for resolving students' doubts and questions back to students themselves or a higher number of pauses and their notably increased length are of particular relevance (Escobar Urmeneta, accepted; Simon Auerbach, forthcoming).

It has also been found that teaching content subjects in the L2 requires the re-contextualization of students' personal experiences and understandings of subject-specific concepts in order to represent them in more general and abstract ways (Gibbons, 2003, 2008). On the other hand, CLIL teachers often guide students' understanding of *unfamiliar* concepts or facts through their comparison to *familiar* objects and processes (Smit, 2010). Thus, for example, through a series of appropriately guided pair/small group activities and a posterior carefully orchestrated class plenary, teachers can both transform potentially difficult and abstract topics into more familiar, interesting and attractive for students and assist the latter in understanding such topics in a better and deeper way (Canet Pladevall and Evnitskaya, 2011; Simon Auerbach, 2012).

Such mediational strategies help teachers not only regularly convert highly conceptualized scientific discourse into student-friendly classroom explanations by basing on students' everyday experiences and ways of speaking but also 'translate' their pedagogical explanations into acceptable school-science discourse in the L2 and vice versa. In this way CLIL teachers build linguistic bridges between different discourses present in their classrooms, thereby guiding students in learning 'science *in* a second language and science *as* a second language' (Roth,

2005b: 56) and ultimately becoming effective 'bilingual' users of school-science discourse and the L2.

Summing up, CLIL teachers need to be skilful in employing a wide variety of interactional strategies, moves and adjustments in order to facilitate students' understanding of school-science knowledge and subject-specific reifications being co-constructed in interaction in the target language, promote students' meaningful participation in this joint process – in spite of their still limited linguistic-discursive repertoire in the L2 – and, finally, guide them in the effective and creative use of such repertoire in displaying their understanding and participation. Among numerous interactional strategies that allow the CLIL teacher to accomplish such diverse scaffolding, Escobar Urmeneta (submitted) lists the following: eliciting students' previous knowledge; explaining concepts related to subject-specific content; giving instructions, commands and warnings; organizing classroom work; checking answers; prompting; providing necessary and appropriate feedback; praising or reprimanding students; and organizing turns of participation in classroom interaction.

It needs to be noted however that interactional scaffolding in CLIL classrooms is still an understudied theme. The need to further our understanding of the phenomenon and spot effective teaching practices which favour active learning and identify what elements hinder it has been determinant for including the examination of teacher's scaffolding procedures as one of the analytic focuses of the dissertation (see chapter 1, section 1.6).

Up to this point a line of argument has been developed that teaching-and-learning of school-science entails that teachers engage students and afford them necessary scaffolding in (a) the social practices of their CLIL science classroom CoP and (b) the joint process of the negotiation of meaning and the construction of shared understandings of academic knowledge. In the next section two more constructs, which may result highly relevant for the exploration and characterization of the way participants – the teacher and the students in the studied CLIL science classroom – achieve these goals by interacting in the target language, will be introduced and discussed in the light of the socio-interactionist

perspective on SLA. These constructs are *interactional competence* and *situated classroom interactional competence*. Finally, recent research on students' *participation* in (L1 and L2) classroom interaction will be reviewed.

2.5. A SOCIO-INTERACTIONIST PERSPECTIVE ON SLA

2.5.1. L2 students' interactional competence from a sociocultural perspective

Current trends within sociocultural research on SLA reconceptualize language learning in L2 classrooms as the result of learners' increasing participation in situated, discursive and interactive practices of these classrooms' communities (e.g., Hall, 1993, 1995; Young and Miller, 2004) and their 'continuous adaptation to the unfolding circumstances and activities that constitute talk-in-interaction' (Mondada and Pekarek Doehler, 2004: 501). More particularly, a conversation analytical, socio-interactionist perspective on SLA (see section 3.3.1.1) develops further such conceptualization of language learning as participation in social interaction and proposes a construct of *interactional competence* (IC) (e.g., Hall, 1995, 2004; Hall and Pekarek Doehler, 2011; see also Barraja-Rohan, 2011 and contributions in Hall, Hellermann and Pekarek Doehler, 2011). Within this perspective, effective engagement in social interactions that take place in L2 classrooms is seen as relying on context-specific knowledge and abilities that participants, that is, teachers and students, deploy to co-construct meanings together through a mutual coordination of their actions.

Such understanding of competence radically differs from the traditional conceptualization of 'features of individual performance which lie[s] at the heart of communicative competence' (Seedhouse and Walsh, 2010: 140). As Nussbaum and Unamuno (2000) argue, the way how, for example, fluency and complexity are dealt with in mainstream SLA do not render well when applied to talk-in-interaction. Therefore, the authors suggest a number of indicators of complexity related to interactional actions that participants undertake in order to achieve their goals within the unfolding talk and to the control these exert over interaction in order to guarantee their efficacy:

Les indices de complexité que nous avons considérés – les façons de participer à l'interlocution, les positions face à l'information disponible et l'information nouvelle, la négociation des rôles communicatifs et des usages linguistiques, les reformulations, etc. – permettent d'identifier la perspective des participants sur leurs actions. Il ne s'agit pas, bien sûr, d'indices exhaustifs, mais d'indicateurs utiles pour rendre compte des modes de réalisation d'une tâche spécifique et des manières d'atteindre les buts que les participants se sont proposés (ibid: paragraphe 49).

Hence, interactional competence is not so much a matter of one's verbal production addressed to concrete interlocutors within a given socio-institutional context, but is rather a two-fold ability to (a) *recognize* context-specific patterns that rule the aspects of turn-taking, the organization of actions and the order of practices in particular social context by developing precise and moment-by-moment understandings of these, and (b) efficiently *attend* to one's interlocutors' contributions, *make decisions* about how to signal their (non-) understanding to the others as well as *coordinate* and *relate* one's own interventions to those of the others, thereby allowing for a mutually shared understanding of the unfolding talk (Hall and Pekarek Doehler, 2011) and a repair of any threat to or breakdown in communication (Barraja-Rohan, 2011).

In case of L2 learners, the development of their IC implies acquiring context-specific and context-dependent knowledge of social and interactional practices typical of L2 classrooms, of specific teaching-and-learning goals and the way these are to be progressively achieved throughout lessons or even activities students engage in and of conventional actions by which participant roles and relationships are accomplished in L2 classrooms (Hall, 2004; Hall and Pekarek Doehler, 2011). All this also means students' constant re-examination of those resources already available to them in the target language which they may use to accomplish appropriate actions in the on-going interaction (Pekarek Doehler and Pochon-Berger, 2011) as well as their acquisition of a gradually increasing toolkit of multimodal resources, that is, linguistic, prosodic, sequential and non-verbal ones. The result is IC in the L2 which students develop over time through taking part in the social activities of the L2 classroom CoP. Such *competence-in-action* (Pekarek Doehler, 2006) is thus seen as adaptive, flexible, highly context-sensitive

and co-constructible between the participants (Hall, 1993, 1995; Markee, 2008; Pekarek Doehler, 2010).

In order to understand how L2 learners display their IC, a number of researchers proposed models and frameworks for the analysis of interaction in language classrooms. One of the first models was that of Hall (1993, 1995) which was later developed by Young (2003). The resulting framework consists of six components (as cited in Hall and Pekarek Doehler, 2011: 4-5):

1. *Rhetorical script* (i.e., knowledge of sequences of speech acts that are conventionally linked to a given type),
2. *Register* (e.g. technical/expert vocabulary),
3. *Strategies for taking turns*,
4. *Topic management* (e.g. the rights to introduce/change topics and their placement),
5. *Roles and patterns of participation related to a given practice* (i.e. novice-expert role-relations; speaker-hearer), and
6. *Boundary signalling devices* (i.e. opening-, transition- and closing-procedures).

However, as Hall and Pekarek Doehler (2011) argue, not all six components are equally useful for the analysis of IC, particularly as elements 1 and 2 are resources that can be employed in any interactive practice and element 5 forms part of more general sociolinguistic knowledge. Meanwhile, it is elements 3, 4 and 6 that may serve researchers as empirically observable indicators of students' IC. These three components, namely, turn-taking, topic management and boundary signalling devices, are what ethnomethodology calls *methods* (Garfinkel, 1967), that is, interactional means and procedures that participants employ to accomplish their actions, give sense to these and make sense of those of others, all this mainly through the use of language (Pekarek Doehler, 2010).

So, following Pekarek Doehler (2010), it may be suggested that the process of developing (and deploying) interactional competence in the L2 may be analyzed

to a certain degree through a fine-grained exploration of elements embodied in social interaction such as repair, hesitation, repetition, turn-taking, and sequential organization (see section 3.3.1). In this study, interactional competence in the target language that ‘silent’ students (see section 2.5.3) display (or not) in the observed CLIL science classroom is the main analytical focus of chapter 6.

2.5.2. *Situated classroom interactional competence in CLIL contexts*

The construct of *Classroom Interactional Competence* or CIC (Walsh, 2006) has been initially developed to interpret interaction in foreign language classrooms. According to Walsh,

CIC is concerned to account for learning-oriented interaction by considering the interplay between complex phenomena that include roles of teachers and learners, their expectations and goals; the relationship between language use and teaching methodology; and the interplay between teacher and learner language. Although CIC is not the sole domain of teachers, it is still very much determined by them (2006: 130).

CIC encompasses those features of conversations between the teacher and the students which result in high quality interaction and thereby make the teaching-and-learning process more efficient. Applied to CLIL settings, understanding the nature of those interactional moves and adjustments that participants accomplish in order to co-construct such high quality interaction is paramount as it might become the bases for teacher education programmes specifically addressed at CLIL teachers.

The following adaptation of Walsh’s (2006) categorization includes some of the teaching strategies so far identified by research:

1. The use of *learner-convergent language*, which is both appropriate to teaching goals and adjusted in relation to the co-construction of meaning and the unfolding agenda of a lesson.

2. The *facilitation of interactional space* so that students are given the opportunity¹³ to contribute to classroom interaction and to receive feedback on their contributions. Teaching strategies that may contribute to afford students interactional space are:
 - effective eliciting strategies in the form of good questions,
 - refining, adjusting and clarifying those questions for learners,
 - allowing for increased wait-time which permits learners to think, formulate and give a response, or
 - promoting extended learner turns by asking ‘why’ questions.
3. The *‘shaping’ of learner contributions* by seeking clarification, modelling, paraphrasing, reiterating or repairing the learners’ productions. Through shaping the discourse, the teacher helps students to say what they mean by using the most appropriate language to do so.

As it can be seen, the majority of these teaching strategies are actually interactional scaffolding strategies (sections 2.4.3 and 2.4.4), the fact that makes the latter a fundamental element in teacher’s CIC. However, it would be erroneous to describe CIC as an inventory of potentialities possessed by individual teachers, who deploy a catalogue of scaffolding strategies independently from macro-, meso- or micro-contexts. On the contrary – borrowing Mondada and Perakek Doehler’s (2004) definition of communicative competence as situated practice – CIC can be envisaged ‘as a plurality of capacities embedded and recognized in the context of particular activities’ (2004: 503). It is therefore teachers’ abilities to make on-line decisions and employ appropriate interactional strategies which allow them to skilfully create spaces for learning and participation in the on-going interaction, that is, to engage students in the negotiation of meanings and the co-construction of academic knowledge in the target language (Escobar Urmeneta and Evnitskaya, forthcoming; Seedhouse and Walsh, 2010).

To sum up, if CLIL settings are to become innovative teaching-and-learning spaces available to students within a wide range of linguistic, academic or social

¹³ Seedhouse and Walsh (2010) suggest labelling such opportunities ‘spaces for learning’.

backgrounds, CLIL teachers need to be able to enact CIC in a context-sensitive way and produce a learning-fostering environment in which students are expected to participate in the co-construction of subject-specific knowledge and to acquire academic competences through the use of the target language (and other semiotic recourses) in which they are apprentices. Being chosen as a transversal theme of the dissertation, analytical chapters 4-6 will explore components of CIC deployed by the teacher in the studied CLIL science classroom in order to tackle – jointly with students – L2 opacity and content density (see section 2.7.3) that emerge in the process of joint construction of academic explanations (see section 2.7)

Let us now turn to the very notion of *participation* in social interactions in the L2 which, it may be argued, represents one of the major issues for SLA research and practice. So, next section briefly overviews relevant recent research on participation in everyday conversations which is followed by a revision of studies on students' participation in classroom settings.

2.5.3. *Students' participation in classroom interaction*

It may be convenient first to go beyond issues of L2 teaching-and-learning and examine the role that the construct of *participation* plays in current understanding of social interaction. In order to do that, a series of questions stated in a recent study on participation in L2 classroom will be borrowed, namely: 'Does someone have access to interaction, and in what capacity? As a speaker? As a hearer?' (Appel, 2010: 207). The following sections will attempt to answer these questions.

2.5.3.1. The notion of participation

Even though not being the first one to conceptualize the construct, Erving Goffman (1981) was nonetheless the first one who attempted to deconstruct the traditional way of analyzing speech events. The research up to that moment was heavily based on a model of communication which took into account only two parties, that is, a speaker who transmitted a message and a hearer who received it. Goffman argued that the model resulted limiting and inadequate because, on the one hand, it did

not 'account for the various and changing alignments participants take towards each other in interaction' (Appel, 2010: 209) and, on the other, it explicitly excluded from the analytical consideration 'other participants potentially involved in any occasion of talk' (Sidnell, 2009: 140). Therefore, in his landmark paper 'Footing' (1981), Goffman decomposed the categories of 'speaker' and 'hearer' into a range of smaller and more subtle categories in terms of *participant roles*¹⁴ in order to capture interactants' alignments and diverse ways of displaying one's involvement in speech events. According to Goffman, these categories are not assigned by one party only but are mutually negotiated (Levinson, 1988).

Although Goffman's work has had a considerable impact on further research for his interest in face-to-face interaction as an object of scientific study *per se*, it has been criticized on various aspects by researchers working within the framework of Conversation Analysis. One common critique is related to Goffman's clear preference for invented examples or his reports of experienced or observed speech events instead of a close examination of the original events through the analysis of their recordings collected and transcribed. Considering that his objective was to explore and describe the details of interactional work carried out by the parties, the lack of actual access to data puts into question the validity of his observations (Schegloff, 1988).

Goffman's participation framework has also been widely criticized for representing different roles and kinds of talk put to work by participants as a highly schematic typology of static categories in which the dichotomy between 'speaker' and 'hearer' is maintained and the priority is clearly given to the former. To overcome such limiting vision, within the field of linguistic anthropology, for example, Goodwin extensively explored participants' different ways of displaying (non-)involvement with the unfolding talk (see e.g., Goodwin, 1981, 2000). Drawing on his findings, Goodwin and Goodwin (2004: 222) defined participation as 'actions demonstrating forms of engagement performed by parties within evolving structure of talk'.

¹⁴ Goffman's participant roles are not presented in detail since they will not be applied in the analytical chapters. Actually, what follows is a critical discussion of his categorization.

Such definition of participation implies a number of fundamental steps forward in understanding the phenomenon. First, participants accomplish their actions within ‘evolving structures of talk’ which can be interpreted as including a wider context and longer stretches of interaction. Second, participants ‘demonstrate’, that is, make observable, a kind of involvement they are accomplishing through their actions. Third, there may be different and changing forms of participation. And fourth, there may be more than just two parties to the on-going interaction.

Hence, participation is redefined in the light of the notions of ‘action’ and ‘situated activity’, being reconfigured moment-by-moment by the participants. The analytical focus needs therefore to be shifted to participants’ organized and systematic *practices* for building actions, practices occurring jointly through which relevant participant roles and situated identities are established and revealed. Such assumptions lead to the conceptualization of co-participants not as merely passive recipients of the speaker’s talk but rather as agents whose actions are locally situated and sequentially accomplished in the unfolding talk.

Finally, Goffman’s conceptualization of participation has been reproached for mainly focusing on the verbal dimension of interaction. Recent research has shown that participation is a more complex phenomenon in the sense that non-verbal mediating means play a central role in the organization of social interactions and in the management of mutual actions (e.g., Goodwin and Goodwin, 2004; Kendon, 1990; Stivers and Sidnell, 2005). These ideas have been coined as *embodied participation* (Goodwin, 1997) (see section 3.3.2).

2.5.3.2. Participation in the classroom

Before turning to the revision of recent research on interaction in the educational context, it may be useful to consider how students’ participation in the classroom has been and is still often conceived. On the one hand, both mainstream research on general education and SLA and classroom everyday practices strongly tend to view students’ participation in terms of verbal production. In case of L2 classrooms, for example, it is traditionally presented as the only expected and

successful way of learning the target language and a clear indicator of students' communicative competence in this language which, obviously, is evaluated according to quantity and quality of its constituting features, that is, complexity, accuracy and fluency (e.g., Douglas, 2000; Lazaraton, 2002; McNamara, 1996; McNamara and Roever, 2006). On the other hand, there are deeply rooted stereotypes of 'passivity', disengagement, and eventual academic failure commonly attributed to students who do not speak in classrooms (e.g., Duff, 2002; Tobin, 2009; van Lier, 2008).

As a consequence, a clear dichotomy between *active verbal participation* and *passive silent non-participation* can be easily observed. However, drawing on current sociocultural assumptions presented in section 2.5.1 that IC is evidenced for those who contribute verbally (in case of the L2 classroom, in the target language), it is legitimate to put forward the following questions: Till what point *students who do not interact verbally in the classroom* are actually passive and do not learn subject-specific content (e.g., science) or the target language? What traits of IC (in the L2), if any, do learners who *remain silent* during the on-going process of the co-construction of academic knowledge display and how they do it? These questions clearly call for an urgent necessity of research on such a highly relevant but generally underexplored topic both in the field of general education and SLA. Research that would seriously take into consideration and examine resources other than purely linguistic ones that students mobilize in order to display their understanding of key aspects of the subject-specific knowledge being co-constructed in the classroom and to contribute to that joint process.

A few recent studies have taken up such a challenge (e.g., Bezemer, 2008; Duff, 2002; Koole, 2007; Sahlström, 2002; Seedhouse and Almutairi, 2009) and paid particular attention to non-verbal actions in the organization of classroom participation. Drawing on their preliminary findings, they argue that learners usually *display* or publicly account for participation or non-participation in classroom activities using a wide range of resources which go far beyond merely linguistic ones. For example, Bezemer (2008) shows how students display attentiveness to a teacher-led activity through the careful alignment in form and timing of their non-verbal 'displays of orientation' (e.g., gaze direction, body

posture, gesture) with the talk and actions of other participants and with the development of the activity.

Koole (2007) examines how learners can also suggest their unavailability for the central, teacher-led activity through their engagement (implicit or explicit) in other concurrent activities. These latter ones usually occur in parallel to the central activity and might be related to the contents of the lesson, that is, to be 'on-task' (e.g., reading the textbook or writing something down in the notebook) or not (e.g., looking outside through the classroom window or chatting to the neighbour on unrelated topics). In case of being 'off-task', these actions are often regarded by teachers as displays of learners' lack of participation. Koole's findings are of particular relevance for the present study due to two reasons. First, they depict whole-class teacher-student interaction as a *multi-party and multi-activity phenomenon*. And second, they reveal that *what actually counts* as learners' participation in classroom activities and *what not* is interactionally established by the participants, that is, by students' actions and teacher's acknowledgment or not of these actions.

A typical non-verbal resource used by students to recognizably display their participation in plenary classroom activities is hand-raising while remaining silent, which conventionally means a bid for the floor. In his work on hand-raising practices within a conversation analytical approach, Sahlström (2002) however demonstrates that such gestures are usually accompanied by a gaze and body orientation towards the teacher, hence displaying learners' listenership or 'recipency' (Sahlström, 1999), that is, the explicit availability to take part in current classroom activities. All three actions result to be precisely coordinated and occur within the teacher's turns. Relating this to the notion of interactional competence, it may be argued that, by displaying non-verbally their precise and moment-by-moment understandings of different interactional activities that usually take place in the language classroom, learners reveal their developing IC in the target language.

Moreover, the exact timing of students' hand-raising in relation to unfolding classroom interaction turns out to be essential for the selection of the next speaker

by the teacher. Namely, while a hand-raising produced at the expected moment displays a bid for the floor, that is, the student's willingness to take the floor and provide a candidate answer, a hand-raising produced just after another student has been selected as the next speaker only displays the knowing of the answer but not willingness to take the floor. So, Sahlström's (2002) findings seem to point to a possibility for students' to display differentiated forms of and ways to 'legitimate participation' through such embodied actions and their timing, from more overt and active participation in which students explicitly project 'speakership' (Sacks, 1992) to what Lantolf (2011) labels *active reception*, arguing that 'the task of understanding and integrating new concepts [and knowledge] <...> is an active process' (p. 307). Interpreting active reception as a type of participation in classroom interaction in the light of Sahlström's (2002) study, it may be characterized by students' demonstrating their reciprocity, 'knowing' and involvement in the current pedagogical activity remaining however silent (and thus not projecting speakership).

Such distinction between overt participation leading to verbal production and active reception partly resembles Duff's (2002) study on participation patterns of 'local', English-speaking students and 'non-local', ESL students in the on-going whole-class discussion on cultural diversity. More particularly, Duff establishes interrelations between the two interactional processes occurring in the classroom: the co-construction of academic knowledge and the establishment and maintenance of students' identities and differences in relation to their ability to speak English fluently or not and their ethnicity and origins. Having analyzed sequential turn-taking among participants and its consequences for the interactional displacement and positioning of students, she concludes that the official school division of students into non-locals and locals highly influenced their participation patterns.

Therefore, on the one hand, Duff shows that non-local students were mainly silent, marginal, and apparently disconnected. 'Silence protected them from humiliation' (Duff, 2002: 312) due to their lack of the oral fluency in the language of instruction (English) but also 'attracted disdain from local students for whom silence represented a lack of initiative, agency, or desire to improve one's English'

(ibid: 312). However, Duff's analysis also reveals that such 'silent' students were actually attentive to what other participants said and even responded – though in a quiet and brief way – when being nominated by the teacher. Hence, she argues that they were accomplishing their own participatory agency, contributing to the joint construction of academic knowledge to the extent they considered necessary and appropriate and leaving enough space for others to intervene.

On the other hand, local students were characterized as highly 'vocal' students who seemed to be successfully socialized into English oral academic discourse. They were observed to self-take the floor and participate actively and verbally in classroom discussions. Yet, Duff argues that interactional patterns of local students resulted to be too invasive and abusive, depriving non-locals of the opportunity to contribute meaningfully while the attitudes of the locals towards non-locals made the latter feel 'sociolinguistically both marginal and marginalized at school' (Duff, 2002: 315).

Finally, Seedhouse and Almutairi's (2009) analysis reveals how a 'silent' L2 learner, which, if being assessed on the basis of only verbal production could have been categorized as not participating, actually displays her involvement with the collective activity in the embodied way through what the authors' call 'silent contribution', that is, for example, the manipulation of material objects. They therefore bring to the foreground the necessity to consider the multimodal aspects of the accomplishment of learning activities when portraying students' participation in the L2 classroom.

Summing up, the revised studies propose a wide range of 'labels' that attempt to depict students' ways of participating in classroom activities, some of which are more or less conventionalized practices (e.g., hand-raising) while others are more tacit and embodied actions (e.g., body and gaze orientation). Nonetheless, the authors still strongly rely on a binary descriptive system (e.g., vocal vs. silent, displayed participation vs. displayed non-participation). There is hence an urgent need for further empirical research on participation in classroom interaction which would approach it in an integrated way and allow for its conceptualization as a more *subtle, complex and gradual phenomenon*. An attempt to further our

understanding of the complexity of this phenomenon will be made in chapter 6 of this dissertation.

The next section presents a review of research on science teaching-and-learning in L1 classrooms carried out within the sociocultural paradigm. Such research may afford the analyst useful insights into what the teaching-and-learning of school-science in the L2 may imply and what challenges teachers and students in CLIL science classrooms may face.

2.6. CURRENT CONCEPTUALIZATIONS OF THE ROLE OF DISCOURSE AND INTERACTION IN SCIENCE CLASSROOMS

In accordance to the objectives of the dissertation (section 1.6), the focus of the review below is on those studies that examine the relationship between science teaching-and-learning and classroom interaction and the role of language in science education. However, it needs to be acknowledged that, despite the best intentions, this review may render incomplete due to the vast amount of studies that might possibly count as part of research on discourse in science classrooms and to the intrinsic limitation of a doctoral dissertation. So, a brief overview of recent sociocultural research on innovative approaches to school-science teaching-and-learning is first presented, which is then followed by a discussion of studies that examined the role of discourse and interaction in science classrooms.

2.6.1. Science teaching-and-learning and interaction in L1 classrooms

Over the last decades, in the field of science education a whole line of research on innovative approaches to teaching-and-learning has consolidated (e.g., Lemke, 1990, 2001; Mortimer and Scott, 2003; Olitsky, 2007; Roth, 2009; Tobin, 2006). It has been argued that science classrooms need to draw on *student-centred* and *practice-based* approaches which foster active learning (Reveles, Cordova and Kelly, 2004; Izquierdo, Sanmartí and Espinet, 1999). From this viewpoint, the teaching-and-learning of science means teaching-and-learning how to *do science*: taught, learned, and done as members of a social community (Lemke, 1990), that

is, a science classroom community of practice (Olitsky, 2007). It means that to enhance the effective learning of school-science there should be enough opportunities for students to engage in meaningful classroom activities under the appropriate guidance of their teachers (Sanmartí, 2003). By promoting collaborative small group work, teachers increase students' autonomy and help them gain in competence and confidence since they gradually remove their scaffolding and hand over responsibility for learning to students (Tobin, 2006; Mortimer and Scott, 2003).

However, many experts in science education warn that in order to foster quality teaching-and-learning it is not enough to just engage students in doing science through 'hands-on' practical activities and lab experiments (Hofstein and Lunetta, 2004; see also contributions in Fraser *et al.*, 2012). Lab experiments, for example, 'can be interesting, motivating and helpful in getting ideas across, but they cannot speak for themselves' (Mortimer and Scott, 2003: 1). As Ford and Forman (2006) argue, science classrooms are to become learning environments that allow students to gain what they call a 'grasp of practice':

Merely holding a test tube or making a poster, for example, is not fundamental in a disciplinary sense. If students are to attain a 'grasp' of how a practice works, they need to engage in those aspects of the practice that are responsible for the grounding of authority and deciding what counts as knowledge (p. 4).

Hence, aspects of participation such as holding a test tube or looking into a microscope are not sufficient in themselves. An essential component of attaining a grasp of practice in science classrooms, that is, 'a basic understanding of the scientific endeavour and how it works' (Ford, 2008: 148), is the students' opportunity to engage in such practice though taking on and 'playing' appropriately relevant discourse roles such as those of Constructors and Critiquers of knowledge claims (Ford and Forman, 2006; Ford, 2008).

This means students' positioning as the authors of knowledge claims and that of (the teacher's or) their peers' as critiquers and vice versa. It implies both the use of appropriate reasoning resources drawing on knowing how, when and why to construct or critique claims and 'an awareness of how one's action [that is,

the construction and critique of claims] interacts with the actions of other roles to support the function of the practice overall' (Ford and Forman, 2006: 16). Interpreting such standpoint in the light of the CoP approach (section 2.3) it means that learning is a process of forming a new identity relevant to the practice (Wenger, 1998) which 'builds upon (and transforms) [students'] current understandings and ways of speaking' (Sohmer *et al.*, 2009: 114).

Along with such claims, other science educators also encourage teachers to create communities of inquiry and practice in their classrooms (e.g., Crawford, 2000; Gallas, 1995; Olitsky, 2007; Roth, 1996) by positioning students as inquirers and co-investigators in open-ended activities (van Zee, 2000). As well as to involve them in actions, conversations, and reflections which are different to those of the communities they value (Reveles *et al.*, 2004). They also highly recommend teachers to engage students in the joint construction of knowledge in pair/small group and whole-class discussions by affording them numerous occasions to express their personal opinions and everyday experiences (Wells, 2001; Yerrick, 2000), on the one hand, and to use the patterns of talk that are more characteristic of science (Osborne, Erduran and Simon, 2004), on the other.

Researchers argue that students' meaningful participation in the co-construction of academic knowledge may contribute to a fuller interpretation and understanding of their classroom experiences in relation to what counts as evidence of scientific knowledge (Floriani, 1994; Kelly and Chen, 1999). As it has been already mentioned in relation to scaffolding in L1 science classrooms (section 2.4.3), science teachers are also expected to afford students access to resources as different as lab instruments, models, visual representations (e.g., maps, diagrams), science reference books or linguistic means (e.g., metaphors, analogies, open and meaningful questions), all of which help represent difficult concepts and natural phenomena, increase students' participation and open their learning horizons (Lemke, 1990, 2001).

The process of teaching-and-learning of school-science is viewed therefore as a fundamentally social and shared pursuit rather than an individual one. In this collective process, participation in the practices of the classroom CoP,

collaboration and interaction with others (both the teacher and the peers) are essential and mutually interrelated components. When teachers and students together make sense of past and current classroom activities and experiences in order to co-construct meaningful academic knowledge, they build 'science as sociocultural practices' (Kelly and Chen, 1999). In supporting this stance, many researchers state that it is through interaction 'around the activities' (Leach and Scott, 2002) that meaning making and learning take place in science classrooms. As Mortimer and Scott (2003) put it:

It is through talk that the scientific view is introduced to the classroom. Talk enables the teacher to support students in making sense of that view. Talk enables the students to engage consciously in the dialogic process of meaning making, providing the tools for them to think through the scientific view for themselves (p. 3).

This role of interaction in the teaching-and-learning of school-science is creatively conceptualized by Lemke (1990) who argues that 'learning science means learning to *talk* science':

'Talking science' does not simply mean talking *about* science. It means *doing* science through the medium of language. 'Talking science' means observing, describing, comparing, classifying, analyzing, discussing, hypothesizing, theorizing, questioning, challenging, arguing, designing experiments, following procedures, judging, evaluating, deciding, concluding, generalizing, reporting, writing, lecturing, and teaching in and through the language of science. (p. ix; original italics).

Learning science implies therefore understanding and acquisition of this specialized conceptual language – *the language of science* – as well as learning how to use it accountably and flexibly both in classroom and other educational settings¹⁵. Lemke (1990) puts these ideas even further and claims that the majority of activities in science classrooms (e.g., reasoning, problem solving and those mentioned in his cite above) are actually and necessarily linguistic activities as well (see also e.g., Kelly, 2007) since they combine two concurrent processes: performing cognitively demanding scientific procedures and communicating complex meanings primarily through language. By seeing *language as a powerful*

¹⁵ Moschkovich (2002) argues the same for the mathematics classroom: 'learning to communicate mathematically is now seen as a central aspect of what it means to learn mathematics' (p. 192).

cultural artefact for a social process of the negotiation of meaning and the co-construction of knowledge for which learning to *speak like (school) scientists* is vital, Lemke goes in line with the current sociocultural views on language as the main tool that mediates the process of teaching-and-learning at school (Mohan, 1986).

Such insights of science educators into the social nature of teaching-and-learning of school-science and the essential role of interaction in this process have considerably influenced research in the field carried out by experts in science education from the LIEC research group at the UAB (e.g., Izquierdo, 2007; Izquierdo and Adúriz-Bravo, 2003; Izquierdo, Espinet, Bonil and Pujol, 2004; Pujol, 2003; Sanmartí, 1995, 1997, 2002, 2003, 2007) who argue that '*el llenguatge permet l'emergència d'explicacions noves, donar nom a les relacions observades, a les noves entitats que les justifiquen; i per això és una eina per canviar la manera de 'mirar' els fenòmens*' (Izquierdo and Sanmartí, 2003: 9).

A relationship between such sociocultural views on science education and the community of practice approach can be established by suggesting that in a science classroom CoP legitimate access to *doing* science means *talking* science.

Talking science implies that students – collaboratively with teachers and peers – renegotiate and reconstruct the ways of acting, reasoning, meaning making, and thinking of scientists (Yerrick, 2005) by learning to construct academic knowledge and understandings of shared classroom experiences together in interaction (see also, e.g., Mercer, Dawes, Wegerif and Sams, 2004). As it has been already discussed in section 2.4.1, this process requires gradually moving from more everyday meanings and ways of speaking to more specific academic discourse of school-science. It also implies using a wide range of non-verbal resources (e.g., gesture, gaze, body orientation and movement, handling of material objects) for negotiating meaning and building the reifications of science classrooms.

Classroom practices of thinking, carrying out observations and measurements, writing, talking and interacting collaboratively following norms, principles and procedures accepted in the community (Lemke, 1990) contribute to

a large extent to the students' understanding, appropriation, affiliation, and construction of their identities (Kelly, 2007) as publicly recognized school-science practitioners (Gee, 2001). They also contribute to the joint creation, or recreation, of a community of people who share certain beliefs and values (Lemke, 1990).

Such perspective on the process of school-science teaching-and-learning as engagement in talking science and other social practices of the science classroom CoP has been skilfully summarized by Kelly (2007, 461-462):

Studies of discourse in science classrooms have contributed to understanding how learning occurs through language, how access to knowledge derives from participating in the social and symbolic worlds, and how disciplinary knowledge is constructed through language.

Let us now turn to the discussion of studies that particularly examined the role of discourse and interaction in science classrooms.

2.6.2. The role of language and discourse in science education

For many researchers in the field (e.g., Ford, 2008; Kelly and Chen, 1999) the above mentioned issues of reconstructing the scientists' ways of acting, meaning making and talking constitute one of the main goals of science education. This goal is actually twofold as it aims to (a) offer students legitimate access to *new conversations* (Sutton, 1996), that is, the specialized discourse of school-science, usually absent from their everyday life through which academic knowledge is constructed, and (b) involve them in making sense of the world around themselves, of one another and to others through their active participation in the social practices of science classrooms (Carlsen, 2007; Lemke, 1990; Sanmartí, 2003).

Researchers on science education also commonly agree that this goal is at the same time one of the major challenges in the teaching-and-learning of school-science due to the very way science is talked into being in classrooms. They argue that there is a clear conflict between the world of scientific fact and the specialized language of science, on the one hand, and the ordinary world of human

uncertainties, judgments, values and one's own interests, and everyday language of human experience, on the other (e.g., Lemke, 1990, 2001; Sutton, 1996, 1998). In order to explain the origins of the conflict, Sutton (1996) shows a difference between two perspectives on language which dominated the research field up to that moment, namely language as an *interpretive system* and language as a *labelling system*.

From the interpretive standpoint, language is viewed as a primary means for the generation of new knowledge and the understandings of new experiences, natural phenomena and the surrounding world through the numerous activities carried out by researchers. It is also considered to play a crucial role in communicating generated knowledge and understandings to the others within a scientific community through persuasion. It is with the help of language that the interaction of three essential aspects that constitute 'doing science' take place: a new way of talking about a certain phenomenon, a new way of understanding or 'seeing' it and ideas for future experiments (Sutton, 1996).

Language as an *interpretive system* is 'an active, flexible tool of thought' (Sutton, 1996: 5) and a modeller of experience (Sutton, 1998) since it influences the way one perceives and reasons about the surrounding world. Being 'a new way of talking', it is full of suggestive metaphors, analogies and colloquialisms as well as narrative and dramatic accounts; it is tentative and lithe, humorous and sensational. Language renders thus to be highly personal, subjective and contextualized, clearly reflecting 'the active interpretive voice of the scientist' (Sutton, 1996: 3) as well as 'aesthetic, intuitive, and emotional components of scientific creativity' (Lemke, 2001: 300), all of which stand behind the major scientific theories and discoveries.

Gradually, through the process of constant negotiation and discussion among scientists aimed at achieving agreements on discoveries and the elaboration of theories, the human activity of exploring, interpreting and formulating new tentative ideas is finally transformed into 'the production of universal statements made by no one in particular to no one in particular <...>

Science becomes information to be received, rather than ideas to be discussed' (Sutton, 1996: 12).

This is a point when a scientific activity turns to be conceptualized within the transmissive perspective in which the scientists' active interpretive voice disappears and language is viewed as a *labelling system*. According to Sutton, this means that language is used to transmit established, impersonal academic knowledge, describe natural phenomena making use of definite and appropriate wordings, report facts, etc. When language is deployed in such a way, it is usually characterized as authoritative, objective, highly analytical and abstract, and universally valid while transmitted information is regarded as precise, timeless truth and the meanings of words as fixed and unambiguous.

So, when turning to science classrooms, Sutton argues that it is mainly the second perspective that is shown, taught and learned. In such a context, students are given the role of passive receivers of established information: they see language as only the labelling system and the communication of scientific knowledge as the question of transmitting facts rather than of sharing personal interpretations or part of the process of the negotiation and construction of new knowledge (Sutton, 1998). Students are not afforded opportunities to use their everyday language actively in order to rediscover, reinterpret and re-talk in their own words what the scientific enterprise is. As Sutton (1996: 13) states, 'with such a limited sense of what language is for, and lack of experience in actively using it, they carry too simple an idea of science as fact-gathering and of language as fact-labelling, and they can become increasingly disadvantaged as learners'.

Such verdict goes in line with the findings of other researchers in the field (e.g., Lemke, 1990; Moje, 1995) who argue that school-science is too often exposed in the classroom in a highly ideological manner, making it less easily accessible to students, while more social and human face of science is never made available to them. As a consequence, the opposition between the two worlds and their languages creates 'much of the 'mystique' of science and the mystification of science' (Lemke, 1990: 134). Therefore, language which is supposedly used to encourage communication among teachers and students and the co-construction

of knowledge in the science classroom becomes one of the principal obstacles for that¹⁶. According to Sutton (1998), teachers need therefore to re-humanize a scientific activity and science in general by recovering the interpretive voice by introducing and treating appropriately three different voices or languages in science classrooms: that of scientists, of teachers and of students.

It may be argued that, on the one hand, Sutton's conceptualization of language as an interpretive system places it at the very centre of the teaching-and-learning process and, on the other, the re-humanization of science he calls for grants students with a voice to be heard and attended to in the classroom. Thus, students are given opportunities to participate actively in the collaborative process of knowledge construction by talking into being their own, individual as well as collective, interpretations of natural phenomena and of classroom experiences through the means of (both everyday and academic) language.

The discussion started by Sutton, Lemke and others in the 90s about the conflict between the language of science and colloquial language that exists in science classrooms is retaken by Carlsen (2007) who states a clearly observable shift in the positions on the role of language that research on science education has undergone recently. To better describe this shift he extends and updates Sutton's (1996, 1998) framework adding a third perspective: language as a *tool for participation in communities of practice*. Drawing on Lave and Wenger's (1991) construct of CoP, Carlsen shows that within the new perspective language is situated in its social context, that is, language and social activities carried out in the science classroom (understood as a CoP) are closely interrelated and intertwined. Hence, as he claims, language use and science learning should be viewed as socially situated accomplishments because language is employed in learning for 'the achievement of a shared understanding' (Carlsen, 2007: 69).

Therefore, in science classrooms, the process of teaching-and-learning is recognized as a school-science activity in its own right which has its own

¹⁶ A similar situation and around the same time was found by Durkin (1991) in math classrooms who reported that 'mathematics education begins in language, it advances and stumbles because of language, and its outcomes are often assessed in language' (p. 3).

educational and discursive practices which are very different from those of scholar scientists, being the school-science activity as authentic within its corresponding context as the scientists' work in its own (see e.g., Ford and Forman, 2006).

Let us now turn to the discussion of one type of social and discursive practice in science classrooms which turns to be the phenomenon under examination in this study, namely, the joint construction of academic explanations. Hence, in the first place, the discussion will focus on research on explanations in L1 science classrooms. Then studies on explanations in CLIL science classrooms will be reviewed. Finally, the notions of linguistic 'opacity' and content 'density' in CLIL classrooms will be presented.

2.7. EXPLANATIONS IN L1 SCIENCE CLASSROOMS AND CLIL CLASSROOMS

In the previous sections it has been already highlighted that producing and sharing new scientific knowledge can be made at different levels of expertise and expressed using different discourses, among others, scientific discourse used by researchers or school-science discourse taught and learned in classrooms. Turning to discursive genres and focusing on one specifically, that is, explanations, experts in science education argue that the objective of both scientific and school explanations is to answer the 'why' and 'how' questions stated by an empirical observation of natural phenomena by establishing relations of complex causality as well as quantitative relationships of proportionality, probability and correlation, all of these in accordance with particular scientific models (Márquez, Roca and Via, 2003; Veslin, 1988).

However, it is obvious that a scientific explanation of a certain phenomenon presented at a specialized scientific conference is not the same as a pedagogical science classroom explanation that aims at promoting students' understanding of the very phenomenon and the construction of common knowledge about it. The former can generally be characterized as theory and evidence-driven, one that makes wide use of generalized, decontextualized and highly specific terminology and analogical models. Meanwhile, the latter, being much more open-ended, can

involve different degrees of ‘explain how’ and ‘explain why’ and heavily draw on students’ commonplace knowledge and experiences (Sanmartí, 2002).

For the purposes of the present study, the discussion below will only focus on school-science explanations which were operationally defined following Jorba *et al.* (2000: 37):

Presentar razonamientos o argumentos estableciendo relaciones (deben haber relaciones causales explícitamente) en el marco de las cuales los hechos, acontecimientos o cuestiones explicadas adquieren sentido y llevan a comprender o a modificar un estado de conocimiento.

2.7.1. Explanations in L1 science classrooms

In L1 science classrooms, explanations are considered essential for science teaching-and-learning since they allow teachers to facilitate students’ understanding of studied scientific phenomena (Ogborn *et al.*, 1996). They are not ‘scientific explanations *per se*’ but rather constitute a very specific type of explanations that integrates two kinds of teacher’s knowledge, that of a science expert and that of a pedagogy expert. Such explanations are what Treagust and Harrison (2000) call teachers’ *pedagogical content knowledge* which highlights their ‘fluid, dynamic and *adaptive nature*’ (ibid: 1168, italics added).

This pedagogical content knowledge hence puts together teachers’ expertise in their subject, a long teaching experience and a classroom-based intuition closely related to their knowledge of each classroom context and individual students. It is this knowledge that enables teachers to *pedagogically transform* complex and abstract scientific explanations of scholars into classroom explanations¹⁷ which are appropriate for the context and precisely customized for their audience. Such appropriateness for each classroom’s context and students is what, according to Treagust and Harrison, makes them *effective science classroom explanations*.

¹⁷ Or in Chevallard’s (1985) terms, to pedagogically transpose *savoir savant* into *savoir enseigné* (see section 2.4.2).

Recent research on science education has shown that teachers construct effective classroom explanations by employing rich and creative metaphors, analogies, models and examples – which often result familiar and accessible to students since teachers borrow them from everyday life (Treagust and Harrison, 2000) – to introduce new concepts and terms, ground them and gradually relate to one another. To attract students' interest, teachers sometimes take the role of 'the teller of tales' (Ogborn *et al.*, 1996) and create school-science 'stories' about the way scientific ideas were discovered, stories which contain plots and subplots and use some of the devices of narrative.

Ogborn *et al.* (1996) suggest four components that make effective explanations: creating differences, constructing scientific entities, transforming knowledge and putting meaning into matter. First component – *creating difference* – means establishing explicit relationships between common everyday knowledge and academic knowledge, between already shared and new knowledge. Second component – *constructing entities* – is related to providing students with different semiotic and material tools that will be later employed (or related to) in explanations: abstract concepts, facts, processes or relations between them, classifications, as well as lab instruments or special scientific objects. The authors argue that prior to constructing explanations such entities need to be 'talked into existence' in order to become part of explanations of some phenomenon ('with which to think') and not things which require to be explained first ('about which to think'). This is why 'much of the work of explaining in science classrooms looks like describing, labelling or defining' (ibid: 14).

Third component is, on the one hand, about the already mentioned transformation of scientific knowledge into accessible and teachable school knowledge (section 2.4.2). On the other, it is about a gradual translation of students' immediate perceptions and empirical observations into the form of abstract conceptual frameworks and theories. It is also about a continuous process of adapting the explanation to the audience - to students' interests, their background everyday knowledge and experiences – and to shared academic knowledge. And final, fourth, component which Ogborn *et al.* call 'putting meaning into matter' is related to science classroom demonstrations and their role in

getting students not only to observe natural phenomena ('seeing-as') but rather see it as scientific theories say they are ('being-as'). This implies that demonstrations and experiments require a lot of imagination on behalf of students in order for them to be able to 'see' and understand many school-science entities which result to be the most abstract and unfamiliar ones or empirically non-observable.

Summing up this section, it can be argued that the set of components that Ogborn *et al.* (1996) propose as constituting effective school-science explanations actually bears a close resemblance with those presented as good scaffolding practices in L2 science classrooms (section 2.4.3). Let us now turn to research on explanations in CLIL science classrooms carried out within the field of SLA.

2.7.2. Explanations in CLIL science classrooms

In research on teaching-and-learning in CLIL settings, explanations represent an understudied theme which is yet slowly gaining its space in the field. For example, Dalton-Puffer (2007, 2011) uses Gaulmyn's (1986) model of explanations (Figure 2.4) to show how this discursive genre functions. This model is formed by three elements: the explanandum or the object to be explained (O), the explicator (S1) and the addressee (S2). Applied to CLIL classroom context, the explicator is usually the teacher who scaffolds the joint construction of subject-specific knowledge in the L2 by making the explanandum, that is, a certain concept or a piece of new subject-matter content to be understood, accessible and transparent for students who are the addressees of the explanation.

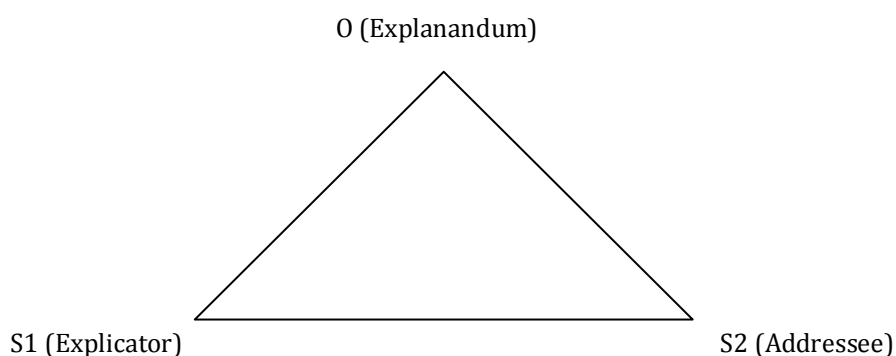


Figure 2.4. Explanation schema by Gaulmyn (1986) as presented in Dalton-Puffer (2007: 140)

The model can serve to illustrate several issues. First, that there is a strong interrelationship between the participants in the on-going interaction and the object of the explanation. Second, the necessity for the teacher to always adapt herself and her explanations to her audience. And, finally, a mediating role the teacher, the 'knowledgeable other' (see section 2.2.2), plays in the social process of the negotiation of relevant meanings and the co-construction of academic knowledge in classroom interaction. These issues establish a direct relation between the adaptive nature of effective classroom explanations and the necessity for the teacher to provide students with numerous, different and rich interactional scaffolding (see section 2.4).

First findings seem to confirm such theoretical postulates and show that effective CLIL science explanations are those that aim at explaining something to someone (e.g., Dalton-Puffer, 2007; Smit, 2010), being thus skilfully crafted by teachers to suit CLIL classroom practices and the needs of students and their level of the target language. Due to the very nature of this educational environment, such adaptive nature of pedagogical discourse results in the almost general inexistence of large portions of monologic teacher's talk better known as 'lectures' and therefore of extended teacher's explanations so often found in traditional L1 classrooms.

Rather, as Dalton-Puffer (2007) observes, teacher-led whole-class explanations in CLIL classrooms are usually *interactive, dialogic* and *distributed* among several participants, which means that they are *interactionally co-constructed by teachers and students*. Simon Auerbach (2012) however argues that teachers' monologic explanations are also necessary because they help students to achieve higher levels of understanding of complex and abstract content of high school science. Her study demonstrates that this is due to the fact that, on the one hand, the teacher provides her monologic explanations once students have extensively worked in pairs on the studied topic and the concepts to be employed in the teacher's explanations and, on the other, that she efficiently employs a wide variety of multimodal scaffolding resources.

Dalton-Puffer's (2007, 2011) findings reveal several interesting aspects related to the process of co-constructing explanations in CLIL settings. First, the co-authors are frequently the teacher and several students which indicate that the explanations are built in *several voices*. In the majority of cases analyzed, students have been observed to supply individual lexical items appropriate for the explanation in course, but it is the teacher who then establishes explicit relations among these items; it is the teacher who 'produce[s] a coherent whole out of the individual items contributed to the floor by the student/s' (Dalton-Puffer, 2007: 158). Second, most of resulting explanations are however left *unsanctioned* as there is no final statement which would link all the pieces and semantic relations together. This is particularly important considering that the explaining process is done orally in interaction.

Finally, Dalton-Puffer (2007, 2011) finds only a few occasions of extended explanations in her CLIL data. Her assumption is that it may be due to the particular – a priori 'bilingual' – settings of CLIL classrooms. The co-existence of two languages seems to allow for an extensive use of what she calls *explaining by translation*: a possibility for both teachers and students to simply provide L1 equivalents of lexical items or concepts in question instead of developing proper school-science explanations (see also Nikula, 2005). However, Dalton-Puffer (2011) questions the effectiveness of such explanations through translation which are too often considered 'to be sufficiently explicit of themselves as if conceptual items were sufficiently explained by lexical items' (ibid: 136).

It is obvious that more research on the topic is needed, particularly a thorough examination of the step-by-step process of constructing dialogic explanations by CLIL teachers and students in classroom interaction and the resources these employ in order to do it. Such fine-grained sequential analysis is presented in analytical chapters 4-6. Finally, to present features that have been found specific to CLIL science classrooms and thereby deepen our understanding of the co-construction of academic dialogic explanations in such educational settings, the notions of *remediation* and *mediation* will be introduced.

2.7.3. L2 opacity and content density

The notions of *remediation* and *mediation* were suggested by Gajo (2007a, 2007b) in order to describe the modes of integration between language (be it L1 or L2) and the subject-matter content that may take place in any classroom. According to Gajo, 'remediation' refers to those situations in L2 classrooms in which language-related obstacles (e.g., a new lexical item) emerged from the 'non-transparency' or *opacity* of the target language are tackled explicitly. On the other hand, the process of 'mediation' allows content subject teachers to present, organize and make relevant subject-specific knowledge, thus dealing with the conceptual *density* that characterizes school academic discourse (Figure 2.5). As a consequence, the more opaque the discourse is, the more explicit remediation is needed; the denser the discourse is, the more mediation is required.

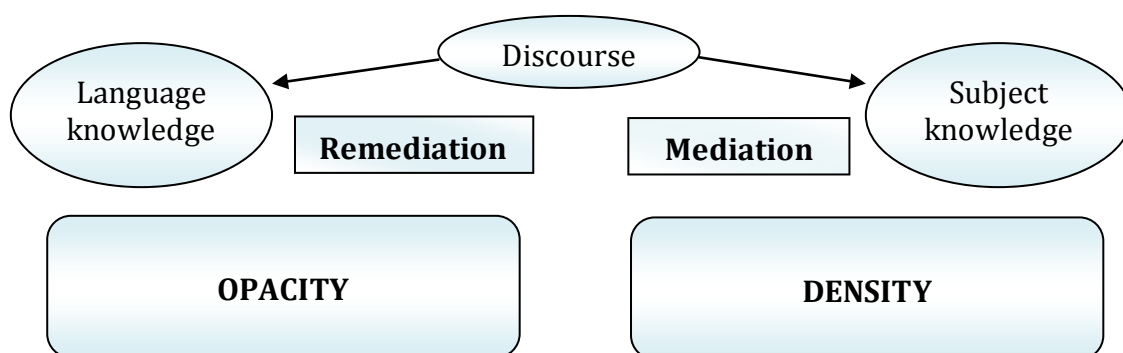


Figure 2.5. A simplified diagram on the processes of remediation and mediation in CLIL classrooms.

Source: Gajo (2007b)

Gajo argues that in L2 classrooms, the teaching process is mainly focused on remediation since there is no subject-matter content to mediate, while in content subjects it is mediation that is problematized explicitly resulting thus in little attention paid to linguistic aspects and very few occasions for remediation created. However, when turning to the CLIL classroom, precisely due to the use of the L2 as a working language, difficulties that emerge in interaction in the process of content mediation can trigger linguistic remediation. Moreover, the processes of remediation and mediation are just two faces of the same discursive phenomenon and both are necessary for the negotiation of meanings and the co-construction of academic knowledge in the classroom.

According to Gajo and his colleagues (Gajo, 2007a, 2007b; Gajo and Berthoud, 2008; Gajo and Grobet, 2008), in such educational environment L2 opacity – rather than being an obstacle – may turn into an opportunity to increase students’ understanding and learning of subject-specific knowledge. In CLIL classrooms, opacity of the target language may also promote work on content density, due to the generation of a particularly favourable interactional space and the emergence of new semiotic tools for the construction and problematization of academic knowledge in the L2. First results obtained by members of the DALE-APECS research project, stemming from the analyses of data collected in CLIL classes in both secondary and university contexts, confirm such assumptions (Borràs, *et al.*, 2010; Borràs, Moore, Nussbaum and Patiño, forthcoming; Moore, 2011; Moore and Nussbaum, 2011; Moore *et al.*, 2012; Simon Auerbach, 2012).

So, an assumption may be put further that the use of the L2, due to its opacity for students, entails remediating discursive practices (e.g., procedures for facilitating understanding and production in the target language or side-sequences containing explanations that deal with the content subject knowledge) that provide insight into the density of the academic content, precisely through interaction among the participants and the negotiation of meaning generated by science classroom activities. Chapter 5 of the dissertation will examine in detail whether it is the case or not in the observed CLIL science classroom.

In this sense, the teaching-and-learning of school-science content in the L2 constitutes a significant asset for the development of teachers’ situated classroom interactional competence. Being chosen as a transversal theme of the dissertation, components of the teacher’s CIC will be identified and portrayed throughout all analytical chapters.

2.8. CHAPTER SUMMARY

This chapter presented the main tenets of current sociocultural perspectives on teaching-and-learning which were adopted as the theoretical framework in this study. First, the chapter provided an overview of the main constructs of Vygotskian sociocultural theory of human learning and development such as mediation,

cultural tools and mediated action, on the one hand, and social interaction, the process of concept formation and the ZPD, on the other. It was followed by a discussion of the implications of Vygotskian sociocultural theory for educational research.

The rest of the sections introduced complementary constructs and perspectives originated in Vygotskian sociocultural theory, namely a Communities of Practice approach to learning, interactional scaffolding, a socio-interactionist perspective on SLA, discourse and interaction in science classrooms, and classroom explanations. It has been shown that, despite the fact that these constructs and perspectives foreground different elements which considered constituting the process of the interactional co-construction of academic dialogic explanations in CLIL science classrooms, they are yet tightly interrelated and overlapping in many aspects. Finally, it has been assumed that the appropriate combination of these constructs and perspectives may offer the given study a rich, multi-level and multi-angle interpretative framework.

In chapter 3 it will be discussed that this framework used along with the conversation analytical machinery (see section 3.3.1) and the multimodal perspective on social interaction (see section 3.3.2) may allow the study to broaden the analytical lens necessary for the detailed examination of the process of co-constructing dialogic explanations and of the resources and competences that the teacher and the students in the observed CLIL classroom deploy in order to carry out this interactional process.

CHAPTER 3: METHODOLOGY

3.1. CHAPTER OVERVIEW

This chapter presents the methodological approach adopted for the collection, treatment and detailed examination of CLIL classroom data (section 3.2). Then, a review of the research tools and methods which were employed to describe and analyze the empirical data is provided (section 3.3). Namely, the fundamental principles of Conversation Analysis (CA) (section 3.3.1), CA-for-SLA (section 3.3.1.1) and Multimodal Analysis (section 3.3.2) are discussed. Then, a combination of theoretical tenets and methodological tools derived from the former – termed here ‘Multimodal CA-for-CLIL’ – will be proposed in section 3.3.3 as the analytical approach appropriate for the examination of classroom interaction in CLIL settings and adopted in this study. To continue, the data corpus is presented (section 3.4). This includes the description of data (section 3.4.1) and participants (section 3.4.2) and the explanation of the procedures followed in treatment and selection of datasets to be examined in analytical chapters (section 3.4.3). Finally, sections 3.4.3.1 to 3.4.3.3 provide basic contextual information on the datasets selected for a fine-grained exploration in analytical chapters 4, 5 and 6.

3.2. METHODOLOGICAL APPROACH

Drawing on current sociocultural approaches to education which conceptualize teaching-and-learning as emerging and occurring in social interaction and which were chosen as a theoretical framework of reference for the given research (chapter 2), this dissertation adopted a primarily exploratory, interpretive and holistic qualitative methodology (Ohta, 2000; Seedhouse, 2004) which allows researchers to further understanding of the complex phenomena that constitute the teaching-and-learning process as it takes place in interactive settings in the classroom.

Applying Kelly's (2007) argument for studying discourse in L1 science classrooms to the CLIL context, this required:

Examining *what counts as science in given contexts, how science is interactionally accomplished, who participates in the construction of science <...>* [A] discourse analytical perspective provides insight into how the events that make up science education are constructed through language and social processes (p. 443: italics added).

More particularly, this implied that different features of classroom interaction together with verbal and non-verbal actions of participants were considered to be of equal value and crucial for a thorough examination of the studied object, that is, the interactional process of co-constructing academic dialogic explanations within a particular setting of one CLIL science classroom in English as the L2. It was also expected that the gaining of deeper insights into the phenomenon may lead to the transformation of educational practices (Guba and Lincoln, 1994; Lincoln, 1993). Hence, the following aspects that constitute the phenomenon were the focus of a close analysis:

1. The way the teacher and the students in the observed classroom use material objects, gestures and talk to mediate the joint construction of dialogic explanations and the outcomes of their negotiation in terms of language and content learning;
2. The way the participants cooperatively tackle L2 opacity and subject-matter content density that emerge in the process of elaborating dialogic explanations;
3. The way 'silent' students display their participation in the process of co-constructing dialogic explanations; and
4. The way the teacher deploys her classroom interactional competence and multimodal scaffolding procedures to guide the students in the joint construction of dialogic explanations.

Therefore, an ethnographic approach to the collection and analysis of data was adopted. This means, that naturally-occurring qualitative data were gathered which mainly consisted of teacher-student interactions in the studied CLIL science

classroom (see section 3.4 below) as well as qualitative analytical tools, that is, Conversation Analysis and Multimodal Analysis, were employed in the data treatment (see section 3.3 below).

The data collection was carried out from an ecological standpoint (van Lier, 2002, 2004) and a highly focused micro-analysis of selected datasets was carried out from an emic perspective (Headland, Pike and Harris, 1990; Nussbaum, Escobar and Unamuno, 2006) which implied always taking into account the participants' positions and establishing analytical categories which participants signalled as relevant, following thereby the principles of Conversation Analysis (Schegloff, 2007).

The dissertation was carried out in the form of a *case study*, a method which investigates the phenomena within a real-life context where multiple sources of evidence are used to construct or inform about the phenomena (Dooley, 2002). According to the overall and specific objectives and research questions stated for the study (section 1.6), the detailed data examination was divided into three studies (chapters 4, 5 and 6). They constituted three distinct ecological and holistic views on the process of the teacher and the students' participation in the co-construction of dialogic explanations in the observed CLIL science classroom, each one approaching the data from different but complementary angles. Taken together, the three studies were aimed to provide a more comprehensible, precise and deeper picture of the interactional phenomenon.

3.3. RESEARCH TOOLS AND METHODS

This interpretive study draws on two analytical perspectives: *Conversation Analysis* and *Multimodal Analysis*. Sections 3.3.1 and 3.3.2 below discuss the basic principles and analytical methods developed within each perspective.

3.3.1. Conversation Analysis

Conversation Analysis (CA), developed from the ground-breaking work of Harvey Sacks in the 1960s (see Sacks, 1992) is 'a method of analysis' (Drew, 2005: 73) for

exploring language use, multiple and diverse resources as well as social interaction through which people accomplish together their everyday, practical activities on a moment-by-moment basis.

Over the last forty years CA research has greatly contributed to understanding participants' everyday practices in producing ordinary conversation (e.g., Sacks, Schegloff and Jefferson, 1974; Schegloff, 2007) and more institutional types of 'talk-in-interaction' (Hutchby and Wooffitt, 2008) which occur in contexts such as courtrooms, doctor-patient consultations, media interviews (e.g., Drew and Heritage, 1992) or L2 classrooms (e.g., Markee, 2000; Pekarek Doehler, 2010; Seedhouse, 2004). Moreover, CA has elaborated a privileged set of tools that allows researchers to explore and describe in detail the ways participants in these interactions use language as a tool to jointly accomplish social actions.

Being interested therefore in actual instances of both mundane conversation and institutional interaction, conversational analysts use audio- and – thanks to the advances in technology – video-recorded episodes of naturally occurring data and their fine-grained transcripts, in which no interactional detail, however small, can be dismissed as irrelevant for the close examination (Heritage, 1984). Rather than imposing theoretical models or frameworks on the data, CA heavily insists on bottom-up and data-driven type of analysis since only in this way researchers can focus on exploring how participants interpret and make relevant one another's actions in interaction and therefore attempt to explicate participants' practices from their own, emic, perspective (Drew, 2005).

Schegloff (2007: xiv) describes six different ways in which social interaction is organized. These 'generic orders of organization' are:

1. *Turn organization and turn-taking*: who should talk next and when;
2. *Action-formation*: how particular actions are produced and recognized;
3. *Sequence organization*: how turns are built successively into coherent sequences;

4. *Trouble*: how conversational ‘trouble’ is dealt with so that the turn, sequence and activity can progress to possible completion;
5. *Word-selection*: what elements are selected as constituent of a turn and how; and
6. *Overall structural organization*: the way the overall composition of interaction gets structured.

While any segment of talk-in-interaction will be found to be intricately organized in all of these ways, it is necessary for the purposes of analysis to focus on one or more specific types of organization. For the purposes of the present study, the focus here is on four of these organizations of practice: (1) turn organization and turn-taking, (2) the production and recognition of specific actions, (3) the building of sequences, (5) and word-selection.

In relation to turn organization it needs to be said that when constructing their turns, participants signal their end by creating *turn-transition relevance places* or TRPs (Sacks *et al.*, 1974). TRPs are appropriate moments in interaction in which the change of the current speaker can take place, either through the selection of the next speaker by the current one or through the former’s self-selection.

The data analyzed in the given study provide numerous examples of both possible changes of speaker at the TRP. Thus, an example of the selection of the next speaker (e.g., a student) by the current speaker (e.g., the teacher) can be a moment when one of the students is nominated by the teacher to report her group’s finding during a lab experiment (see section 4.4.1, Excerpt 3.2, line 514). Meanwhile, an example of a self-selected next speaker is the case of another student, not nominated by the teacher, who at some other moment provides his candidate response in the L2 to the teacher’s question about the handout in her hand (see section 6.2.1, Excerpt 5.1, line 11).

When participants take turns at the interactional floor – the right to speak – and produce their social action, they ‘display in their sequentially ‘next’ turns an understanding of what the ‘prior’ turn was about’ (Hutchby and Wooffitt, 1998:

15). This means that by producing a turn, that is, a first action, the current speaker provides the next speaker with an interpretative context to understand this first action (Sacks *et al.*, 1974). In their turn, the next speaker (either the one selected by the current speaker or self-selected) becomes the current speaker and produces their own (second) contribution to interaction which displays the interpretation of the first one and simultaneously creates an action to be interpreted in the next turn, and so forth. In the two examples mentioned above in relation to turn organization, each student displayed their understanding of the teacher's turn as a nomination to report or as a question, respectively, by providing their appropriate report or answer to that question, correspondingly.

So, this *next-turn proof procedure* (Sacks *et al.*, 1974: 729) is a basic device that participants employ in order to construct, display and check *intersubjectivity* (Schegloff, 1991), that is, 'the maintenance of a world (including the developing course of interaction itself) mutually understood by participants as the same world' (Schegloff, 1991: 151). Such mutual understanding of the current sequential and social context by participants is based therefore on previous turns and projects next turns. As a result, participants' contributions to on-going interaction are both *context-shaped* and *context-renewing* (Schegloff, 1996) in the way these maintain social order, organize turn-taking and coordinate mutually understandable actions.

The same interactional device – the next-turn proof procedure – also serves researchers to carry out a systematic sequential analysis, that is, the discovery, description and examination, of 'the organizational features of various, naturally occurring, interactional phenomena' (Psathas, 1995: 45) from an emic perspective which can reveal the details of the moment-by-moment unfolding of interaction (Pekarek-Doehler, 2010).

Having applied this CA principle to plurilingual talk, Auer (1984, 1998, 1999) demonstrates that in order to signal how their turns are to be interpreted, plurilingual speakers recurrently deploy *code-switching*, a conversational resource which he defines as 'the alternating use of more than one language' (Auer, 1984: 1) within the same interactional episode. Auer and other researchers (e.g., Gafaranga,

2001; Wei, 1998; see also contributions in Wei, 2005) have also found that in plurilingual interactions subsequent speakers often prefer to maintain the language employed by the previous speaker. In research on code-switching, such 'sequential implicativeness of language choice in conversation' (Auer, 1984: 6) is referred to as the principle of 'continuity'.

CA hence 'not only demonstrates what understandings the interactants display to each other, but also how they do so by normative reference to the interactional organizations' (Seedhouse and Walsh, 2010: 130). According to Sacks (1992), participants can display their understanding of a prior turn in two ways: through *claims* and *demonstrations*. When one of the parties merely acknowledges the reception of information they produce a *claim of understanding*. Such claims often contain a token 'oh'. This token usually indicates a speaker's change-of-state from not-knowing to knowing (Heritage, 1984), thereby marking the receipt of all the information that the sequence was initiated for and proposing its closing (Schegloff, 2007). However, when participants do 'some sort of analysis' of the previous speaker's utterance and use 'that analysis in producing [their] next utterance' (Sacks, 1992, Vol. II: 253), they then produce a *demonstration of understanding*.

Hence, for example, when a student quickly produces a token 'oh' in the L1 (see section 4.4.1, Excerpt 3.6, line 531) he publicly claims his understanding of shared school-science knowledge being jointly built by other interactants. On the contrary, a demonstration of understanding could be, for example, the teacher's utterance 'Ja.: (0.5) if it changes its *↑shape*'¹ once the misunderstanding between her and two students has been overcome and the negotiation of meaning has been successfully closed (see section 4.2.1, Excerpt 1.6, line 87).

The above discussed findings led Sacks *et al.* (1974) to claim another key principle in CA, namely, 'one-turn-at-a-time' allocation which means that only 'one party talks at a time' (ibid: 699). It should be noted, however, that early CA analyses (e.g., those of Sacks, Schegloff or Jefferson) were based on conversational data taken from audio recordings and therefore had no access to non-verbal

¹ See Appendix 1 for CA transcription conventions adopted in this study.

aspects of interaction. Such methodological and analytical limitations have been largely overcome with the arrival of video-typed data which gave rise to the reconsideration of 'one-at-a-time' principle (see section 3.3.2).

Interaction is also organized in relation to actions, such as, for example, asking, answering, (dis)agreeing or requesting, which participants accomplish when they engage in social practices. Here emerges what Schegloff (2007: xiv) calls the 'action formation' problem: the way how participants employ different verbal and non-verbal resources (e.g., language, body, gesture or material artefacts) to accomplish their actions and have them recognized just as such. However, these actions do not appear as isolated entities. At the very least, participants expect that their actions will be responded to, thereby becoming a part of 'coherent, orderly, meaningful successions or *'sequences' of actions'* (Schegloff, 2007: 2, italics added).

In CLIL settings, many actions can be found relevant to the classroom CoP practices of talking (school-science) accountably in the target language. Among them will be, for example, explaining, describing, requesting, responding to a request or a question, agreeing, disagreeing, telling, noticing, providing feedback or admonishing. The issue for participants in CLIL classrooms – in particular for students – is how they use a set of resources available to them to carry out and recognize these actions.

The main interactional mechanism for building such sequences of actions in talk is the *adjacency pair*. Adjacency pairs are linked pairs of turns produced by different interactants: a first pair-part (FPP) and a second pair-part (SPP). In both informal and classroom contexts a wide range of examples of adjacency pairs can be found: greetings/farewells which are expected to be returned with another greeting/farewell; news waiting for either a positive assessment of 'newsworthiness' or a negative assessment (or rejection) of the information as 'news'; questions expecting answers, rather than rejections, in return; requests which can be met with acceptance or decline; or assessments which can be followed by agreement or disagreement.

These examples help understand the basic functioning of adjacency pairs. The FPP initiates an exchange and makes *conditionally relevant* a SPP which needs

to be responsive to the action of a prior turn. This responsiveness is reflected in that the SPP provided is to be a preferred interactional action. This means that such SPP is to be treated by the previous speaker as a more favourable or unproblematic action than certain others which are seen as *dispreferred* ones.

In classrooms, adjacency pairs are overwhelmingly sequences of teacher-initiated questions and students' responses. The former can be seen as the FPPs and the latter as the SPPs, the latter being preferred interactional actions, irrespectively of whether they are correct or not from the viewpoint of subject-matter content. Meanwhile, the student's rejection to provide an answer would be interactionally treated as a dispreferred action. Yet, as it will be seen in the analytical part of the dissertation, apart from questions and answers there are other possibilities of adjacency pairs.

Originating in Ethnomethodology (Garfinkel, 1967), CA concepts of 'preference' or 'dispreference' in no way refer to participants' tastes or desires but rather to the 'issues of affiliation and disaffiliation, of seeing, noticeability, accountability, and sanctionability in relation to social actions' (Seedhouse, 2004: 23). Abundant CA research on preference organization has provided important insights into the topic. First, it has shown that the issue is actually a question of numbers: what is done more frequently is preferred and what is done less is dispreferred (e.g., Heritage, 1984). Second, that for the majority of FPPs there usually exist two alternative SPPs (e.g., Atkinson and Heritage, 1984; Boyle, 2000) as in case of some examples above. And finally, that there are differentiated ways of performing each option (e.g., Lazaraton, 1997; Pomerantz, 1984).

Adjacency pairs can be developed into longer but still tightly organized sequences by introducing additional parts, namely, *pre-*, *insert* and *post-expansions* (Schegloff, 2007: 26). The latter literally 'enter' the very body of an adjacency pair so that the resulting full sequence may be as following: Pre-expansion -> FPP -> Insert expansion -> SPP -> (optional Sequence-closing third and/or) Post-expansion. If all of these expansions occur within the same sequence, then quite long and elaborate structures constructed around a single 'base' adjacency pair can be produced.

An example of an elaborated sequence containing almost all possible additional parts (except for Pre-expansion) could be the following situation (see section 4.4.1, Excerpt 3.1): the teacher nominates a student to read aloud a statement which his group has examined under the microscope during a lab experiment (FPP) -> the student requests clarification from the teacher who provides it (two-part Insert expansion) -> the student reports his group's finding (SPP) -> the teacher acknowledges the student's intervention and provides a prolonged reconstructive recap (Sequence-closing third and Post-expansion).

Finally, the organizational practice of selecting appropriate linguistic items for each part of adjacency pair can show how participants employ different discursive and lexical meaning making resources in dealing with what Schegloff (2007) calls the 'word-selection' problem. That is, 'how do the components that get selected as the elements of a turn get selected, and how does that selection form and shape the understanding achieved by the turn's recipients?' (ibid: xiv).

By focusing on word-selection in CLIL settings, the researcher can examine the way teachers and students employ different concepts, terms and categories for the negotiation of meaning and the co-construction of academic knowledge in the target language in the CLIL classroom. Or the way participants move between more 'everyday' language and more 'scientific' discourse when they introduce reifications specific to the practice of school-science. This is the case, for example, when the teacher in the observed CLIL science classroom skilfully navigates between two academic terms 'harmful' and 'beneficial' and their everyday counterparts 'bad' and 'good' while co-constructing a dialogic explanation with the students (see section 5.2.1, Excerpts 4.3-4.5).

3.3.1.1. CA-for-SLA

In the field of research on SLA, Conversation Analysis has become extensively employed after Firth and Wagner's (1997) call for the reconceptualization of the field towards more social perspectives on language learning. A successful and productive adoption of conversation analytical procedures and instruments for the study of L2 teaching-and-learning from the socio-interactionist perspective on

learning resulted in an innovative research approach known as *CA-for-SLA* or *CA-SLA* (e.g., Firth and Wagner, 1997, 2007; Markee, 2000, 2008; Mondada and Pekarek Doehler, 2000, 2004)².

CA-for-SLA is primarily concerned with a close examination of the way L2 classroom interaction is organized on a moment-by-moment basis in order to identify those interactional patterns, formats and situations that foster (or hinder) L2 learning (e.g., Hellerman, 2008; Kasper, 2006; Pochon-Berger, submitted; Seedhouse, 2004). This means exploring social, contextual and interactional dimensions of L2 learning and acquisition (Markee, 2000): the way how it originates from and is configured through social practices and interaction in which L2 students are engaged in the classroom (e.g., Pekarek Doehler, 2006; Seedhouse and Walsh, 2010).

Following CA principles, CA-for-SLA draws on an emic standpoint in its accounts of how teachers and students in the L2 classroom make use of the target language in order to participate in interaction and accomplish situated social practices in which they simultaneously orient to the rules of such practices, appropriate linguistic norms and mutual organization of actions (Markee and Kasper, 2004)³. Therefore, such 'strong' socio-interactionist view of SLA (Mondada and Pekarek Doehler, 2004) can 'provide a fundamental contribution to the understanding of both the context-dependent and the context-renewing methods by which learners become competent members in a community of practice' (Mondada and Pekarek Doehler, 2004: 503) of their L2 classroom.

It has been already discussed above (section 3.3.1) that CA rejects any external theoretical frameworks or models to be imposed on the data and instead lets 'data speak for itself' (Jenks, 2010: 149). In the field of SLA such stance has

² See also Kasper (2004); Markee and Kasper (2004); Mori (2004); Seedhouse (2004, 2005); Wagner (2004), among many others.

³ In parallel to a more Anglophone tradition and without adopting the name of CA-for-SLA, a whole line of interactionally-oriented research on L2 language learning in and outside classroom settings has been done over the last decades in francophone Europe (e.g., Bange, 1992, 1996; Dausendschön-Gay, 2003; Krafft and Dausendschön-Gay, 1994; Lüdi, 1982, 1993; Nussbaum *et al.*, 2006; Nussbaum and Unamuno, 2000, 2005, 2006; Pekarek Doehler, 2000; Py, 1991, 2007).

resulted in the emergence of *data-driven* CA-for-SLA research (e.g., Jenks, 2010; Mondada and Pekarek Doehler, 2004). Yet, some studies adopt a *theory-driven* (Markee and Kasper, 2004) or *theory-informed* (Jenks, 2010) approach since they combine exogenous theories such as, for example, CoP approach or sociocultural theory with the analytical power of CA and thereby gain further insights into the situated language learning (e.g., Mori 2004; Seedhouse, 2004; Young and Miller, 2004).

Another recent distinction has arisen due to the degree to which CA basic principles (e.g., emic perspective or the sequential organization of interaction) are interpreted and applied by CA-for-SLA researchers. This has led to the differentiation between a *pure CA* approach to SLA data (e.g., Markee 2000, 2005) and a *linguistic CA* approach (e.g., Seedhouse, 2005).

In the light of the above presented characteristics of current CA-for-SLA research, this dissertation can be situated within a *strong* and largely *theory-driven* perspective on CA-for-SLA which applies a *pure CA* approach with the aim to explore the interactional process of co-constructing academic dialogic explanations in the target language in the observed CLIL science classroom. However, the study goes beyond what CA-for-SLA may offer the analyst for the exploration of interactional social practices in the CLIL science classroom CoP. More specifically, it applies an approach which is slowly gaining advocates among researchers working in the field of bilingual, plurilingual and CLIL education and which is termed here 'Multimodal CA-for-CLIL' (see section 3.3.3) .

3.3.2. *Multimodal Analysis*

Due to technological progress in data collection procedures since 1960s which allowed naturally occurring data to be video-recorded, MA is another perspective that in the last decades has being increasingly adopted by researchers who study social interaction, being it mundane conversation or institutional talk-in-interaction. Though drawing on frameworks as different as, for example, sociocultural theory or Systemic Functional Linguistics (Halliday, 1978; Halliday and Matthiessen, 2004), all of them nonetheless coincide in their interest in *non-*

verbal communication and meaning making resources beyond that of language which participants rely on in mediating and facilitating their interactional practices.

From this perspective, language is often seen as having a ‘satellite’ function (Kress, Ogborn and Martins, 1998; O’Halloran, 2006), that is, it is used in conjunction with other semiotic resources, at times being the dominant means in the process of meaning making and at other times having more of a background or supporting function. Thus, apart from prosody (e.g., pitch movement or intonation, volume, speed of delivery or rhythm, stress and stretching) which constitutes paralinguistic means and usually accompanies language⁴, face-to-face interaction also involves the deployment of non-verbal resources⁵ (Goodwin, 1981; Goodwin and Goodwin, 1992).

These non-verbal resources embrace eye gaze, facial expression, gesture, head movement, body movement and posture, all of which can be used singly or concurrently with or without talk (Mondada, 2008; Pekarek Doehler, 2010). However, their role in interaction is not limited to mere ‘providing the necessary context’ (D’hondt, Östman and Verschueren, 2009: 8). Rather, different resources are actively engaged in establishing coherent sequences of actions (Goodwin, 1981, 2000; Stivers and Sidnell, 2005).

Thus, gaze direction, body movement and posture align participants and help to choose a recipient for one’s utterance (Hellermann, 2008). They can also display the individual’s (or mutual) orientation to certain material objects or activities: participants in a working meeting looking alternatively at colleagues and documents on the table (Mondada, 2008) or archaeologists bent over a colour chart (Goodwin, 2000). In the present study, for example, several students simultaneously gazed at a handout in the teacher’s hand since it was relevant for

⁴ The example already provided in section 3.3.1 on demonstrations of understanding – ‘*Ja:: (0.5) if it changes its *ʃ*shape*’ – also illustrates some prosodic elements deployed by a participant, namely, intonation (marked with pointed arrows) and stretching (colons).

⁵ The account on non-verbal meaning-making resources presented below mainly draws on research carried out within CA perspective on social interaction.

the ongoing classroom activity (see section 6.2.1, Excerpt 5.3, Figure 5.3-a) or the teacher and a student were oriented towards a microscope in order to evidence students' findings during a lab experiment (see section 4.3.1, Excerpt 2.2, Figure 2.2-c).

Gestures also contribute to the organization of social interaction since they allow interactants to regulate turn-taking, elicit feedback, mark agreement or direct their own and other participants' attention (Kendon, 2004; Mondada, 2007). All these visual orientations are therefore essential for the interactional organization of participation (Goodwin and Goodwin, 2004; Kendon, 1990; Stivers and Sidnell, 2005): they help parties to dynamically (re-)configure relevant participation frameworks within unfolding interaction (Moore, 2011). Such research on semiotic resources other than language has led to a reconsideration of a basic CA principle of 'one-at-a-time' speaker (section 3.3.1) and offered instead the understanding of social interaction as a *multi-party phenomenon* (e.g., Goodwin and Goodwin, 2004).

In the data analyzed in this dissertation (chapters 4, 5 and 6), gesture played an important role, so let us now focus on it in more detail. Gestures within talk as a meaning-making resource have attracted particular attention both within general education (McNeill, 1992, 2005) and SLA research (e.g., Gullberg, 2006, 2010; McCafferty, 2002; McCafferty and Stam, 2008). McNeill (1992) describes four types of gesture, namely iconic, metaphoric, deictic, and beat.

Iconic gestures or illustrators are closely related to the semantic content produced verbally since they are primarily used to represent concrete physical objects, actions, and events due to their resemblance to them. For example, when the teacher – to reinforce her verbal message in the target language (*'it's rounded'*) – aids it visually by circling an image in a biology reference book with her finger (see section 4.2.1, Excerpt 1.7, Figure 1.7-e).

Metaphoric gestures are also used for depiction, but they represent abstract ideas rather than concrete objects. This type of gestures has not been found in the examined data. However, an illustrative example is given in McNeill (1992: 14): in order to introduce a cartoon he had just seen and was about to relate, an

interactant uttered '*it was a Sylvester and Tweety cartoon*' while raising his hands as if he were offering an object to other participants – a pictorial representation of the cartoon as a whole.

Deictic or pointing gestures are not representational but are usually used as a talk-related referential resource to direct the interlocutor's attention by indicating physically present objects, persons, or places (Goodwin, 2003). They are also systematically employed by participants to impose their self-selection as a next speaker (Mondada, 2008) as well as to make visible their engagement and participation in interaction (Kendon, 2004; Mondada 2007). An example of a deictic gesture could be the teacher pointing at an image in the reference book and then at a student in front of her while explaining the difference between the image and what the student and his partner have seen under the microscope (see section 4.2.1, Excerpt 1.7, Figures 1.7-b and 1.7-c).

Beat gestures are quick rhythmic movements of the hand timed with the speech they accompany to mark certain points or concepts as being significant and can be obvious enough or quite subtle. These gestures have neither been identified in the data explored in the dissertation. However, one occurrence has been found when nods were employed with the same aim (see section 5.2.1, Excerpt 4.4, lines 92-93).

A fifth type of gesture which can be added to this quartet is 'interactive' (Bavelas, Chovil, Lawrie and Wade, 1992) or 'interactional' (Evnitskaya and Morton, 2011) gestures which are related to turn-taking in interaction. These gestures are used to regulate interaction among participants, that is, to initiate, maintain, synchronize, organize, or terminate a particular joint action.

Such corporal multimodality is highly pertinent to teaching-and-learning of school-science (Givry and Roth, 2006; Roth and Lawless, 2002). It has been shown that science classrooms are particularly intensive in the range of non-verbal resources that teachers and students deploy for the construction of relevant meanings and academic knowledge (e.g., Ford, 1999; Kress, Jewitt, Ogborn and Tsatsarelis, 2001; Macbeth, 2000; Márquez, Izquierdo and Espinet, 2003, 2006).

As Tobin (2006) explains in describing a vignette of classroom interaction in an urban science classroom, ‘talk, gesture and body movement are coordinated with the manipulation of lab materials to maintain focus among the group members and assist them to reach consensus on what is happening in the lab’ (ibid: 233). Apart from non-verbal means, the presence of *symbolic representations* and *mathematical language*, a wide range of *visual materials* (diagrams, charts, maps, etc.) and *physical objects* (handouts, textbooks, blackboard, pens and pencils, chemistry or biology lab tools, etc.) in science classrooms highlights the importance of considering the way participants in classroom interaction use them as meaning making resources (Poizzer-Ardenghi and Roth, 2010; Carlsen, 2007; Roth and Welzel, 2001).

3.3.3. *Multimodal CA-for-CLIL*

Recently various researchers in the field of SLA and CLIL have attempted to combine conversation analytical machinery with the multimodal perspective in order to further understanding of the teaching-and-learning process taking place in bilingual immersion classrooms and plurilingual and CLIL settings.

For example, Moschkovich (2002) studies bilingual (Spanish-English) students in a mainstream math classroom in the United States. She shows how a situated-sociocultural perspective on language and mathematics learning can provide insights into Latino students’ participation in mathematical practices. More particularly, Moschkovich reveals a variety of multimodal meaning-making resources (L1, everyday register, gestures and material objects) used by students to effectively ‘communicate mathematically’ (ibid: 190), thereby widening our understanding of what it means to learn mathematics.

Drawing on the socio-interactionist perspective on SLA, Pitsch (2005) examines teacher-student interaction in a bilingual (French as the L2) immersion history classroom in Germany. Being interested in the way a teacher focuses on history content and the L2 in his discourse, the author shows that he first systematically marked certain subject-specific concepts as important by employing a range of multimodal resources (e.g., hesitations right before the key word,

emphasis, gaze) and then initiated sequences of the negotiation of meaning in order to clarify or translate the concepts presented in the L2. Pitsch argues that in this way concepts and pieces of academic knowledge became linguistic 'objects' and were afforded students as such.

In his case study on a CLIL geography lesson in English in Germany, Kupetz (2011) applies an interactional-linguistic perspective in order to closely look at the multimodal collaborative accomplishment of a student-initiated explanation in the CLIL classroom. He reveals that students deploy an array of finely coordinated multimodal resources (e.g., the target language, pause, facial expression, pointing, other gestures) to construct relevant meanings as part of the interactional activity of 'explaining'. Kupetz also shows how this activity is sequentially organized and collaboratively accomplished by all participants, that is, the student who initiated the explanation, the teacher and other students, despite language and content problems which emerge in the course of the activity.

Recent studies carried out within the GREIP research group (UAB) on tertiary education (e.g., Moore, 2011; Moore and Nussbaum, 2011; Moore *et al.*, 2012) draw on sociocultural approach to learning, and more particularly to cognition, in their exploration of the internationalization processes in two Catalan universities which take place both inside and outside the classroom context. Moore (2011) shows that participants define the context of the plurilingual practices they engage in by employing plurilingual (i.e., code-switching) and multimodal resources available to them. She provides a detailed sequential account of the way participants interactionally create opportunities for situated learning practices in non-classroom environment.

Moore (2011) also has a close look at CLIL university classroom settings. This study as well as Moore and Nussbaum (2011) and Moore *et al.* (2012) focus on interactions generated within small group work and lectures. They explore how teachers and students plurilingually and multimodally manage their comprehension of (and attention to) subject-specific content and the level of complexity of this content as well as their participation in the joint construction of

(content and language-related) knowledge in the process of accomplishing different teaching-and-learning activities.

Within the DALE-APECS project, in their preliminary study Evnitskaya and Morton (2011) combine the CoP approach to learning, CA and the multimodal perspective on social interaction for the detailed analysis of CLIL classroom data. Namely, they study how the processes of the negotiation of meaning and identity formation occur in knowledge construction, meaning-making and interaction in two CLIL (science in English) classrooms in Spain. The authors show that the theoretical-methodological combination allows for a sequential micro-analysis of talk and other semiotic resources which CLIL teachers and students mobilize in order to build and maintain their science classroom communities of practice as well as to accomplish learning and identity formation. The findings show the complex patterns of participation and reification as participants use different multimodal resources for meaning making.

The revised studies demonstrate that, due to the detailed explications of the different organizations of practice in their sequential and interactional context which CA methods and instruments afford researchers, its combination with the multimodal approach to data and the current sociocultural approaches to teaching-and-learning renders very well suited to capturing interactional social practices of the negotiation of relevant meanings and the co-construction of academic knowledge in (immersion and) CLIL classrooms. To emphasize the constituting elements of this promising analytical methodology it was decided to denominate it *Multimodal CA-for-CLIL*.

This is the analytical approach to CLIL data adopted in the present study for the in-depth exploration of the interactional process of joint construction of academic dialogic explanations in the observed CLIL science classroom and of the resources and competences that the teacher and the students in this classroom deploy in order to accomplish this process. To achieve this goal, each analytical chapter takes on different specific sociocultural constructs that contribute to shed light on the interactional phenomenon in question by examining it from different angles. Thus, chapter 4 combines the construct of *mediated action* (section 2.2.1)

with *multimodal CA* and *the CoP approach* for the data analysis, thereby extending Evnitskaya and Morton's (2011) proposal. Chapter 5 closely examines the data through the lens of the constructs of *opacity* and *density* (section 2.7.3). Chapter 6 carries out a detailed – sequential and multimodal – exploration of how the constructs of *interactional competence* in the target language (section 2.5.1) and *participation* (section 2.5.3) are displayed by 'silent' students in interaction in the observed CLIL science classroom. Finally, all three chapters also apply the construct of *classroom interactional competence* (section 2.5.2) in order to explore scaffolding procedures employed by teacher to guide students in the joint construction of dialogic explanations.

3.4. THE CORPUS

3.4.1. Data description

Empirical data analyzed in this study come from a larger CLIL corpus which forms part of the DALE-APECS database. Data collection was carried out over a period of seven weeks (October-December 2009) by a university-based researcher, the author of the given dissertation, who acted as a participant observer. The data were gathered during the implementation of a twelve-week CLIL teaching unit *Life on Natural Sciences* (biology) in English at a state-funded secondary school in a middle-class neighbourhood in Barcelona, Spain. The whole data corpus to which the analysed sets of data belong include primary conversational data and complementary data sources.

1. Primary data consist of:

- Audio and video recordings of eight⁶ CLIL science lessons, each of approximately 50 minutes-long. There is a total of 5 hours 57 minutes and 22 seconds of recording.

⁶ Following the agreement with the teacher, session 1 was not video-recorded in order for students to get used to the presence of a camera and the participant observer in the classroom. In this session only field notes were taken.

2. Secondary data:

- Detailed field notes taken by the participant observer for all nine lessons;
- One video-recorded interview with the teacher (1h);
- Two audio-recorded working sessions with the teacher (24 minutes and 50 minutes, respectively), and
- Teacher-made CLIL biology materials⁷ used throughout the implementation of the unit.

3.4.2. *Participants*

The participants were a CLIL biology teacher and her 16 twelve-year-old students who were in their first year of compulsory secondary education. The researcher also participated in some of the interactions as a peripheral participant. The teacher and the class found themselves in a bilingual educational system in which Catalan and Spanish were used as first languages and English was taught as a foreign language and is gaining grounds as a third academic language (Escobar and Nussbaum, 2010).

At the moment of data collection, students roughly displayed a COE A2.1 level of competence in English, according to the Common European Framework of Reference for Languages (CEFR) (Council of Europe, 2001). Biology was the only CLIL subject the class was offered that year and for some students it turned out to be their first CLIL experience while others, according to the teacher, were already familiar with this approach as they had participated in CLIL programmes in primary school. In respect to the teacher, she had twenty five years of experience of teaching Natural Sciences in L1 in state-funded secondary schools and was in her second year of teaching CLIL biology classes. Her level of competence in English was a certified B2. This information is summed up in Figure 3.1:

⁷ See Appendix 2 for teaching materials. They are also available at the CLIL-SI website: [http://grupsderecerca.uab.cat/clilsi/> Materials > Science](http://grupsderecerca.uab.cat/clilsi/>Materials>Science).

<i>Teacher's experience</i>	Experienced (25 years L1 science; 1 year CLIL science)
<i>Teacher's level of English</i>	B2 CEFR
<i>Number of students</i>	16
<i>Age</i>	12
<i>Class</i>	1 st year of lower secondary education (compulsory)
<i>Students' average level of English</i>	A2.1 CEFR
<i>Sitting arrangement</i>	1. Circle. The teacher forms part of it (sessions 1-3 and 5-9). 2. Three rows, in pairs/small groups (session 4, experiment).

Figure 3.1. General contextual information on the participants

Eight of the nine sessions (sessions 1-3 and 5-9⁸) took place in Laboratory 1 (biology laboratory room, see Figure 3.2). In these sessions, students sat in a circle around a big common table made of 4 desks put together in the centre of the room. The teacher, instead of using her own desk situated next to the blackboard, always sat together with the students.

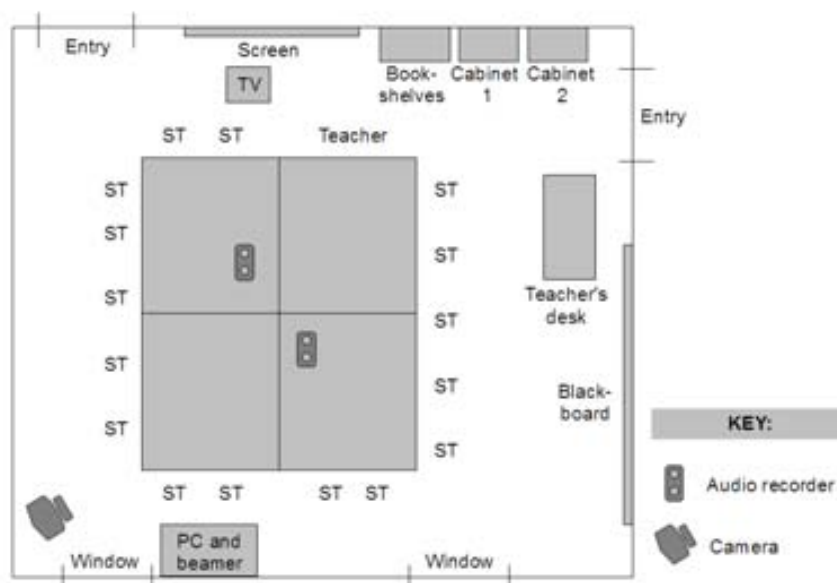


Figure 3.2. Spatial distribution of Laboratory 1

⁸ Numbers given to sessions refer to their order in the data corpus rather than their place within the teaching unit. Thus, for example, session 4 means that it is the fourth recorded lesson and not that it was the fourth session of the teaching unit, since the data collection started in the sixth week of the implementation of the unit.

Session 4 took place in Laboratory 2 (chemistry laboratory room, see Figure 3.3) due to the specificity of the lesson which was a lab experiment. In this laboratory, desks were put together into three long rows and there was special equipment for carrying out lab experiments (e.g., plugs in each table, a sink, specific lab materials and tools).



Figure 3.3. Spatial distribution of Laboratory 2

Throughout the implementation of the unit, the participants mainly worked with teacher-made CLIL biology materials (dossier and handouts)⁹. To facilitate teaching-and-learning process other relevant classroom and lab artefacts were also made use of. These artefacts comprised lab instruments such as light microscopes and other tools necessary for experiments, models of internal human organs, L1 reference biology books, bilingual dictionaries, posters and charts containing subject-specific information on biology topics, a blackboard, a PC with a beamer and a screen.

⁹ The materials had been designed by the teacher two years earlier and piloted in the same school the academic year previous to data collection. The designing and piloting processes were carried out under the supervision of two professors from the UAB, Dr. Cristina Escobar Urmeneta (expert in Language Education) and Dr. Neus Sanmartí Puig (expert in Science Education).

3.4.3. *Data treatment and selection*

Video recordings of eight lessons were transcribed by the author and the research technician of the DALE-APECS project using *Transana* software (Woods and Fassnacht, 2007). Detailed transcripts of talk and some non-verbal actions (gestures, head movements and the handling of objects) were made employing CA transcription conventions proposed by Jefferson (2004), which are given in Appendix 1.

Once the transcripts were obtained, a two-stage analysis was carried out. The two stages are what Erickson (2006) describes as a ‘molar’ and ‘molecular’ analysis, correspondingly. A first, preliminary or ‘molar’, analysis consisted of the multiple close reading of transcripts of the whole corpus and multiple visioning of related video-recordings. Then specific episodes or *interactional projects* which evidenced the presence of the interactional co-construction of academic dialogic explanations in the CLIL science classroom were identified, described and coded.

From the whole number of identified interactional projects, a total of 5 were finally chosen for the second stage of the analysis due to their representativeness: the abundance of interactional phenomena of high complexity, worth of a more close examination. Though the analytical chapters of this dissertation (chapters 4, 5 and 6) focus exclusively on this second phase of the analysis, they yet would not have been possible without the molar stage.

The construct of ‘interactional project’ is in fact one of the outcomes of this piece of research and it has emerged from the interface between the methodological framework adopted and the in-depth exploration of the interactional data in the corpus. The following definition is proposed:

An ‘interactional project’ or IP is a conversational macro-sequence which may occur in any interactional context – but which is applied here exclusively to classroom settings – and which fulfils the following requirements:

1. *It has a discernible interactional goal towards which the participants’ verbal and/or non-verbal actions are oriented;*

2. *It reveals a certain agenda (or agendas) which participants pursue by accomplishing their actions;*
3. *It has a clearly marked beginning and end; and*
4. *It develops over a span of time, not necessarily through consecutive sequences or adjacency pairs.*

In the second, 'molecular', stage of the analysis, the transcripts of the selected interactional projects were thoroughly revised and improved by the author paying particular attention to participants' multimodal actions and their length. With this aim MA conventions proposed by Mondada (2008) and further developed and adapted by Moore (2011) and Moore and Nussbaum (2011) were primarily used (see Appendix 1). In the transcripts, non-verbal actions such as gaze orientation and shift, gesture, head and body position and movement, and the use of material artefacts were represented providing line-to-line, brief but as precise as possible descriptions. Additionally, information on multimodal actions which would render relevant for the analysis was supplied with video screenshots embedded into the transcripts. To protect anonymity of the participants in the study, pseudonyms were used for their real names.

Once the revision and improvement of the transcripts was over, their micro-sequential and fine-grained analyses were carried out in order to identify, examine and characterize the following aspects:

- a) The participants' use of **multimodal resources**, that is, material objects, gestures and talk in order to mediate the joint building of dialogic explanations,
- b) Their cooperative tackling of L2 **opacity** and content **density** that emerge in the process of elaborating such explanations,
- c) '**Silent**' students' displays of **participation** in the process of co-constructing dialogic explanations, and
- d) Teacher's **classroom interactional competence (CIC)** and **scaffolding** procedures in guiding students in this process.

A first molecular and close approach to the transcripts revealed that the four aspects mentioned above were present in all interactional projects and pointed to the high interrelatedness and intertwining of these aspects. With the aim to facilitate the analytical procedures and the posterior reading of the analyses, it was decided to divide the interactional projects into three datasets. Similarly, the process of data exploration was divided into three studies (chapters 4, 5 and 6) which applied different theoretical tools (chapter 2) to bring valuable insights into the nature of the studied phenomenon from different viewpoints. Each study mainly – but not exclusively – focused on the aspects (a) *multimodal resources*, (b) *opacity and density*, and (c) *silent participation*, respectively. Meanwhile, aspect (d) *CIC and scaffolding* was dealt with transversally in all analytical chapters. Due to a rather considerable length of each interactional project (and the corresponding transcript), these were divided into a series of shorter excerpts which significantly facilitated the fine-grained exploration and interpretation of the selected datasets.

Sections 3.4.3.1 to 3.4.3.3 below provide a brief outline of the three datasets selected for the exploration in the analytical chapters. A more detailed description of each dataset will be provided at the beginning of each analytical chapter (see sections 4.1, 5.1 and 6.1, respectively).

3.4.3.1. Dataset 1

The first set of data consists of three interactional projects (1-3) which were divided into seventeen excerpts for their subsequent analysis in chapter 4 (see Figure 3.4 below): interactional project 1 (Excerpts 1.1-1.8), interactional project 2 (Excerpts 2.1-2.3) and interactional project 3 (Excerpts 3.1-3.6). All three interactional projects were taken sequentially from session 4¹⁰. It was the second lab experiment in the corpus¹¹.

¹⁰ See Appendix 2, pp. 52-53.

¹¹ The first lab experiment was carried out in session 1 in which only field notes were taken.

The session was dedicated to the classification of microorganisms into large groups called *Kingdoms* through the study of their main features. Hence, students were organized into six pairs and one triad in order to carry out an experiment on one-celled microorganism called *Euglena* mainly using a light microscope and a handout designed by the teacher. The handout, distributed among the groups, contained a list of possible characteristics of the microorganism (see Appendix 3) to be checked by students during the experiment. After the experiment, there was a class plenary in which students presented their findings and verdicts on whether *Euglena* was a plant, an animal or neither. This was followed by the negotiation of a joint verdict and a final teacher's presentation of the official scientific classification of *Euglena*.

3.4.3.2. Dataset 2

The second set of data consists of one interactional project (4) which was divided into six excerpts (Excerpts 4.1-4.6) for their subsequent analysis in chapter 5 (see Figure 3.4 below). Interactional project 4 was taken from session 2¹².

This teacher-led session was dedicated to different types of cells. First, two activities on the previously covered content, namely, main features of the following cells: bacteria, amoebas, animal cells and plant cells, were checked. After that, students carried out two main activities on new content: (a) estimation of the size and shapes of animal cells and (b) matching words and definitions of different specialized cells (e.g., red blood cell, neuron, muscle cell).

3.4.3.3. Dataset 3

The third set of data consists of one interactional project (5) which was divided into five excerpts (Excerpts 5.1-5.5) for their subsequent analysis in chapter 6 (see Figure 3.4 below). Interactional project 5 was taken from session 3¹³.

¹² See Appendix 2, pp. 30-33.

¹³ See Appendix 2, pp. 39-40.

This teacher-led session was mainly dedicated to work on the classification of living beings into the following groups: kingdom, phylum, class, order, family, genus, and species. However, first, homework was assigned which consisted of a 'hands-on' activity on the organization of human body and was designed to review previously covered content. After that, students had to carry out two main classroom activities on new content. The first one was a reading comprehension activity. The second one was a 'hands-on' practical activity related to the content studied in the previous activity (a text on groups of classification of living beings).

Description (number of IPs and Excerpts)		Identification	Format	Length
Dataset 1: IPs (3), Excerpts (17) Taken from session 4	IP 1: <i>Change the shape</i>	Excerpt 1.1	Audio + video	0'15"
		Excerpt 1.2	Audio + video	0'08"
		Excerpt 1.3	Audio + video	0'12"
		Excerpt 1.4	Audio + video	0'08"
		Excerpt 1.5	Audio + video	0'15"
		Excerpt 1.6	Audio + video	0'06"
		Excerpt 1.7	Audio + video	0'19"
		Excerpt 1.8	Audio + video	0'06"
	IP 2: <i>Like a whip</i>	Excerpt 2.1	Audio + video	0'11"
		Excerpt 2.2	Audio + video	0'15"
		Excerpt 2.3	Audio + video	0'25"
	IP 3: <i>We've been heating it so much, it's dead</i>	Excerpt 3.1	Audio + video	0'27"
		Excerpt 3.2	Audio + video	0'08"
		Excerpt 3.3	Audio + video	0'05"
		Excerpt 3.4	Audio + video	0'28"
		Excerpt 3.5	Audio + video	0'16"
		Excerpt 3.6	Audio + video	0'08"
Dataset 2: IP (1), Excerpts (6) Taken from session 2	IP 4: <i>What does 'harmful' mean?</i>	Excerpt 4.1	Video	0'15"
		Excerpt 4.2	Video	0'12"
		Excerpt 4.3	Video	0'10"
		Excerpt 4.4	Video	0'12"
		Excerpt 4.5	Video	0'20"
		Excerpt 4.6	Video	0'06"
Dataset 3: IP (1), Excerpts (5) Taken from session 3	IP 5: <i>Different levels of organization of human body</i>	Excerpt 5.1	Video	0'10"
		Excerpt 5.2	Video	0'10"
		Excerpt 5.3	Video	0'16"
		Excerpt 5.4	Video	0'11"
		Excerpt 5.5	Video	0'11"
Key: 0'05" = 0 min 5 seconds				

Figure 3.4. Data corpus analyzed in this study

3.5. CHAPTER SUMMARY

This chapter started with the presentation of the methodological approach adopted for the collection, treatment and detailed examination of CLIL classroom data. It also provided a review of the research tools and methods employed for the data micro-analysis. Finally it provided detailed information on the data corpus, the participants, the procedures undertaken in the data treatment, and the datasets selected for the fine-grained analysis.

CHAPTER 4

STUDY 1: INTERWEAVING OBJECTS, GESTURES, AND TALK IN THE CO-CONSTRUCTION OF DIALOGIC EXPLANATIONS IN THE CLIL SCIENCE CLASSROOM

4.1. CHAPTER OVERVIEW

This chapter will present a close examination of three interactional projects, all of which come from the same session 4 (see section 3.4.3.1) on the classification of microorganisms into large groups called *Kingdoms* through the study of their main features. The analysis is lead by the following research question:

How do the participants use material objects, gestures and talk to interactively mediate the co-construction of dialogic explanations and what are the outcomes of their negotiation in terms of language and content learning?

It uses the constructs of *mediated action* and *Communities of Practice* (CoP) in order to explore and describe the multimodal mediating process through which the teacher and the students in the studied CLIL science classroom jointly construct, negotiate and develop contextually appropriate shared understandings within their CLIL science classroom CoP.

Additionally, interactional scaffolding provided by the teacher in the process of constructing dialogic explanations will be explored in order to identify and portray the components of her classroom interactional competence.

4.2. INTERACTIONAL PROJECT 1: *CHANGE THE SHAPE*

In session 4, the students, who had chosen their own partners, were organized into six pairs and one triad in order to carry out a lab experiment on one-celled microorganism called Euglena. To do it, they were expected to mainly use a light microscope, other lab instruments necessary for the experiment and a handout designed by the teacher. The handout, distributed among the students (one copy per pair) at the beginning of the lesson, contained a list of possible characteristics of the microorganism (see Figure 4.2-1 below for a small-scale size; see also Appendix 3 for the original size) which students were expected to check during the experiment. When necessary, students could also consult a biology reference book in Catalan in which they could find images and basic information on different microorganisms, among which the studied one, Euglena.

It doesn't have a cell wall	It has got chloroplasts
It has got a nucleus	It is not a one-celled organism
It can absorb food through the membrane	Euglena generated confusion among scientists
It is usually green	Its nucleus contains DNA and controls the activities of the cell
The chloroplasts allow it to make photosynthesis	A vacuole controls the liquid inside the cell
It swims in water	It can make its own food
It contains a vacuole	Euglena is sensitive to light
It has got a cytoplasm	Euglena can change its shape
Euglena lives in ponds and lakes	Euglena is sensitive to temperature
Euglena can reproduce	There must be more than two groups of classification

Figure 4.2-1. The handout used during the lab experiment

The session consisted of the following phases:

1. Preparation for the experiment (pair work):
 - 1.1. In pairs, students generated their predictions on the classification of the studied microorganism (plant, animal or neither).

2. Laboratory experiment (pair work):
 - 2.1. In pairs, students observed *Euglena* under light microscopes and identified its characteristics among those listed in the handout;
 - 2.2. In pairs, students discussed those characteristics (given as statements) from the handout that they had been able to observe, validated (or refuted) their initial prediction and finally elaborated a verdict on the classification of *Euglena*.

3. Class plenary (whole class):
 - 3.1. During this whole-class activity, each pair presented their findings and verdicts on the studied microorganism;
 - 3.2. The teacher and students discussed presented findings and verdicts and negotiated a final joint verdict;
 - 3.3. The teacher presented the officially accepted scientific classification of *Euglena*.

Interactional projects 1 and 2 have been taken sequentially from activity 2.1 which lasted for approx. thirty minutes, while interactional project 3 comes from activity 3.1 which lasted for approx. five minutes. As it has been already explained in section 3.4.3.1, with the aim to facilitate the comprehension of the analyses each interactional project has been divided into several shorter Excerpts. Hence, interactional project 1 entitled *Change the shape* takes place in the last 10 minutes of activity 2.1 and is comprised by four main Excerpts (1.1, 1.6-1.8) which are analyzed in detail and four complementary Excerpts (1.2-1.5). Interactional project 2 entitled *Like a whip* occurs approx. two minutes later and consists of three Excerpts (2.1-2.3). Finally, interactional project 3 entitled *We've been heating it so much, it's dead* happens approx. eight minutes after the second one. It belongs to the final plenary activity (activity 3.1) and contains four main Excerpts (3.1-3.3 and 3.6) which are analyzed in detail and two complementary Excerpts (3.4-3.5).

4.2.1. Analysis

The participants are the teacher (TEA) and two students (Quim, QUI, and Jaume, JAU), who work together in the first row. Figure 4.2-2 presents their spatial distribution in Laboratory 2.

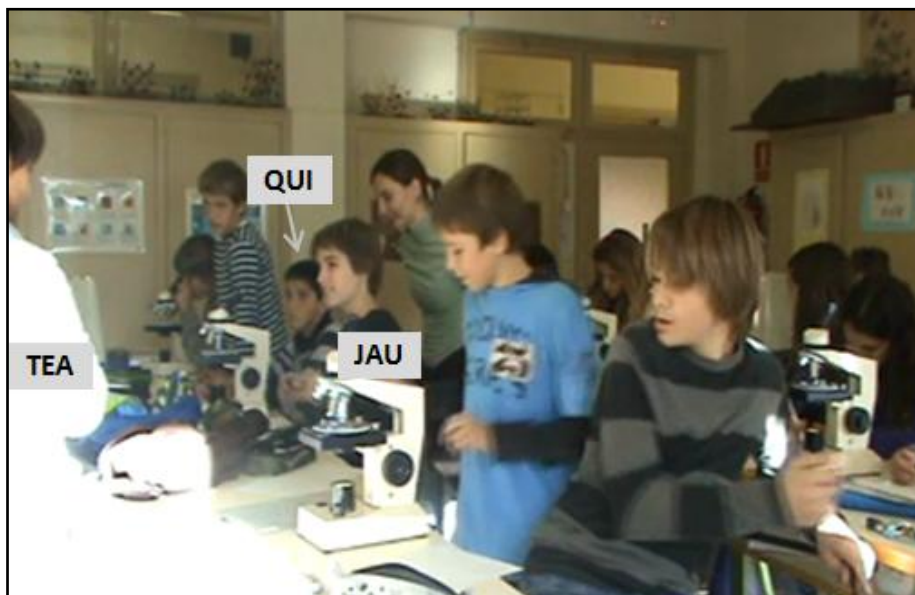


Figure 4.2-2. Spatial distribution of the participants in interactional project 1
(Figure corresponds to Excerpt 1.1, line 86)

The interactional project takes place during the experiment, more concretely, during the observational activity 2.1. It consists of four Excerpts¹ which sequentially show how two students – who have faced a problem related to one of the statements in the handout (‘Euglena can change its shape’) – resort to the teacher who, in turn, initiates a sequence of the negotiation of meaning by providing the scientific meaning of a lexical item used by one of the students (Excerpt 1.1). Once the students make explicit their own understanding of the item and the teacher shows her previous misunderstanding, the negotiation of meaning is ended (Excerpt 1.6). After that, the teacher initiates an explanation of the phenomenon that has provoked the students’ problem and the students participate

¹ Excerpts 1.1 and 1.6-1.8. Excerpts 1.2-1.5 are given as complementary data to support the argument being developed in the analysis.

² Due to the impossibility to hear these students’ private conversation which formed part of multiple simultaneous interactions carried out by other participants it is impossible to distinguish the words produced by Quim. The interpretation offered here is based on the numerous visions of

in the elaboration of the explanation (Excerpt 1.7). Once the co-constructed explanation has been developed, the teacher and the two students jointly solve the problem which has triggered interactional project 1 (Excerpt 1.8).

Excerpt 1.1 begins with a student in the first row, Quim, addressing his partner, Jaume (see Figure 4.2-2 above), with an intelligible utterance in the target language:

Excerpt 1.1

74. *qui* addresses JAU

75. **QUI:** †change the shape

76. *jau* addresses TEA

77. **JAU:** Eug†lena=

78. *qui* addresses TEA

79. **QUI:** change the shape?

80. **JAU:** =is metamorphil?

81. **TEA:** metamorphic is a rocks (1.0) metamorphic.

82. **QUI:** change the shape

83. **JAU:** metamorpho- (0.2) metamorphic (.)

84. *què és? què canvia la forma?*

Translation: what's it? that it changes the form?

85. **QUI:** [change the shape

86. **JAU:** [o: :-?

Translation: or

Quim's intervention in line 75 concerns one of the statements from the handout (see Figure 4.2-1 in section 4.1) which contains a list of possible characteristics of the microorganism under study (Euglena) and which has been distributed among the students at the beginning of the lesson with the aim to guide them during the lab work. Figure 4.2-3 shows the statement in question.

Euglena can change its shape

Figure 4.2-3. The statement from the handout that triggers interactional project 1

Quim's utterance seems to have emerged as a result of his previous private discussion with his partner². The latter however orients himself to the teacher rather than to his classmate and initiates his turn (addressed to the teacher) by naming the microorganism (**Eug[†]lena**, lines 76-77). The fact that both students produce their turns with slightly rising intonation allows for an assumption that they have not arrived to an agreement on whether the microorganism can change its form or not and therefore decide to resort to the teacher's expertise. This assumption is confirmed by their next interactional moves. Namely, Quim physically reorients towards the teacher to whom he resends his utterance which he now clearly shapes intonationally as a question (lines 78-79). As for Jaume, he finishes his turn with a direct request to the teacher on whether **Euglena is metamorphil** (line 80) thus publicly announcing their problem. Jaume's question shows him using the target language creatively since he generates a lexical item ('metamorphil') which does not exist but which still highly resembles a subject-specific reification in the L2 proper of scientific discourse.

The fact of such resemblance is corroborated by the teacher's reaction in line 81 who identifies the item as such. In her turn the teacher provides no expected action within the student-initiated adjacency pair that would be an answer to Quim's implicit and Jaume's direct question about the nature of the microorganism but instead opens a side-sequence of the negotiation of meaning. The teacher initiates it with an interactional instance of the integrated treatment of the subject-specific content and the target language. More precisely, she produces two other-repairs of Jaume's use of the item. One is implicit and focused on form since she changes the student's contrived form 'metamorphil' to the accepted one ('metamorphic'). The other repair, focused on meaning and related to the content, is much more explicit: the teacher employs the item as a geological term to refer to

² Due to the impossibility to hear these students' private conversation which formed part of multiple simultaneous interactions carried out by other participants it is impossible to distinguish the words produced by Quim. The interpretation offered here is based on the numerous visions of the seconds of the video file prior to Excerpt 1.1.

a scientific name of a type of rocks called ‘metamorphic rocks’³. To strengthen her message, she emphasizes the word ‘rocks’ and, after a notable pause of 1.0 second, repeats the term. So, the teacher supplies the students with the correct reification and re-contextualizes it in order to explicitly show them that the interactional context in which it has been used by Jaume is not appropriate.

The subsequent contributions of Quim and Jaume in lines 82-86 shed light on the fact that the teacher and the two students actually do not assign the same meaning to the lexical item in question. And each student tries to contribute in his own way to the on-going interactional process of the negotiation of meaning by clearing out the problem. Thus, Quim conveys the idea by directly repeating his previous utterance **change the shape** twice (lines 82 and 85): first, after the teacher’s mentioning of rocks, and, second, after his peer’s much more explicit contribution in lines 83-84, in this manner reinforcing the latter. Meanwhile, in his turn Jaume is seen to first recycle the repaired item since he produces a tentative **metamorpho-**, which, after a micro-pause, he self-repairs into **metamorphic** (line 83). Then he publicly problematizes the term by asking the teacher straightforwardly about its meaning (*què és?*, ‘what’s it?’) and specifying whether it means ‘change the form’ or something else (*què canvia la forma? o:::-?*, lines 84 and 86).

The analysis carried out so far allows for two tentative observations. First, the two students seem to *effectively deploy* both the target language and the L1 as mediating tools in interaction in order to find some common ground (Klaassen and Lijnse, 1996) with the teacher that would allow both parties to construct a shared understanding of the phenomenon within their classroom CoP. And second, their attempts to make the problematic item less opaque suggest that they (a) *know* its literal meaning – perhaps due to the existence of its cognates in Catalan and Spanish (*‘metamòrfic’* and *‘metamórfico’*, respectively) – which comes from Greek words ‘change’ and ‘form’, and (b) actually *use* the item in this very meaning. Moreover, Jaume’s resort to the L1 in his clarification requests to the teacher

³ This type of rocks is the result of a physical/chemical transformation of existing rocks due to changes in surrounding temperature and pressure.

clearly indicates his confusion due to her re-contextualization of the item in the field of geology.

Such interpretation of students' contributions (and particularly those of Jaume in lines 83-84 and 86) finds additional support in the rest of the data. The results of the search of the word base 'metam-' common to the L1 and the L2 throughout the whole data corpus have shown that Jaume used lexical items containing this base on two more occasions earlier that very lesson. The first time occurred approx. 2 minutes before Excerpt 1.1 when the students were privately discussing (mainly in the L1) different statements listed in the handout while trying to observe them under the microscopes (Excerpt 1.2, see interventions by Ricard, RIC, Joan, JOA, and Sara, SAR). It is precisely in this context of experiential group work that Jaume produced an L1 utterance '*L'Euglena no és metamòrfica*' (line 36) which states for 'Euglena is not metamorphic'.

Excerpt 1.2

30. ric *looks into microscope----->
31. RIC: *no (.) jo crec què no pot (0.5) jo crec què no pot.
Translation: no (.) I think it can't (0.5) I think it can't
32. joan *looks into microscope----->
33. JOA: ↓sí què pot (.) tío.
Translation: yes it can (.) dude
34. sar *looks into microscope----->
35. SAR: **i hi ha una altre coseta de que ja no és MOU*
Translation: and there is another little thing that doesn't move any more
36. JAU: *l'Euglena no és metamòrfica.*
Translation: Euglena is not metamorphic

The second occurrence happened just a few seconds before Excerpt 1.1 during a whole class discussion on the nature of the studied microorganism (Excerpt 1.3 below). The teacher initiated the discussion by first publicly announcing difficulties that emerged in one of the pairs - due to their contradictory findings which evidenced that Euglena had the characteristics of

both animals and plants – and then posing controversial questions such as ‘How can it be?’, ‘Is it [Euglena] a plant or is it an animal?’ and ‘Can we classify it?’. The teacher’s questions generated a hot debate among the students (see interventions by Sara, Andrew, AND, and Gerard, GER) who proposed different names and categories for the observed microorganism among which there also was that of Jaume: ‘*hombre* (.) it’s a metamorphinaplus’ (‘man, it’s a metamorphinaplus’) in line 65.

Excerpt 1.3

58. *tea* *addresses the class*
59. **TEA:** **so (1.0) can we classify it?**
60. **SAR:** **IT’S A PLANIMAL**
61. **AND:** **IT’S A PLANIMAL**
62. **GER:** **IT’S A FUSION**
63. **SAR:** **it’s a plant and animal**
64. **AND:** **it’s a PLANIMAL**
65. **JAU:** ***hombre* (.) it’s a metamorphinaplus**
- Translation: man, it’s a metamorphinaplus

Such Jaume’s intervention is of special interest in several aspects. First, he employed an L1 discourse marker ‘*hombre*’ to introduce the rest of his utterance in the L2 thereby relying on code-switching. In such a way he effectively added an ‘emphatic’ voice and projected that what he was going to say deserved special attention (Simon Auerbach, 2011): namely, the microorganism’s classification as ‘metamorphinaplus’. Second, this time his utterance was produced mainly in the target language. This could be due to the fact that the preceding contributions of other interactants were made in the L2 (on the contrary to what has been observed in Excerpt 1.2), thus reflecting the principle of ‘continuity’ in code-switching.

And finally, his utterance was also appropriate both from the perspective of language and the subject-specific content. Linguistically, because his contribution contained a full syntactic construction usually found in L2 classrooms: ‘noun + to

be + indefinite article + noun'. In respect to the school-science content, because he skilfully devised an L2 lexical item which highly resembled a scientific reification in Latin. His newly coined word therefore perfectly met a rule which the students had read in a text in their dossiers⁴ in session 3 (see Figure 4.2-4):

Each living thing is given a **scientific name** based on its genus and species. Latin is used in scientific names to make them easier to understand.

Figure 4.2-4. The rule assumed to be applied by Jaume in Excerpt 1.3, line 65

The complementary data below show that this rule was also alluded to by the teacher later in the same session 3 (Excerpt 1.4) and a month later in session 9 during the exam revision (Excerpt 1.5):

Excerpt 1.4

10. **TEA:** I put it in ↓Latin (.) because m::
 11. ↑most (.) most times the ↑names (.) are in Latin.

Excerpt 1.5

48. *tea* *reads----->
 49. **TEA:** *how are species named by scientists?*\br/>
 50. *addresses the class*
 51. they are named by two ↑words written in ↓Latin (.)
 52. in order to m:: to put a name for everybody in the world.

So, the complementary data have been presented to illustrate the suggestion emerged from the analysis of Excerpt 1.1 that the two students, and particularly Jaume, clearly comprehended the meaning of the term 'metamorphic' and employed it in their interaction with the teacher in its literal sense of 'changing physical form'.

⁴ See Appendix 2, p. 39.

Let us now turn to the analysis of Excerpt 1.6 in which the sequence of the negotiation of meaning between Quim, Jaume and the teacher has been successfully closed and the misunderstanding has been overcome⁵.

Excerpt 1.6

87. **TEA:** ↓*a::* (0.5) *if it changes its* ↑*shape*

Translation: oh::

88. **JAU:** *yes*

89. **TEA:** *I think so* (0.5)

90. *but we cannot see it today.*

91. **JAU:** *para nada*

Translation: at all

92. **QUI:** *xxxxxx*

The teacher's turn ↓*a::* (0.5) *if it changes its* ↑*shape* in line 87 begins with a 'news-receipt' (Heritage, 1984) in the L1. Besides containing a change-of-state token 'oh' (↓*a::* in Catalan/Spanish), it also reveals the teacher's analysis of Quim and Jaume's previous interventions and can thus be seen as her demonstration of understanding of the students' questions in lines 77-80 (Excerpt 1.1).

However, the sequence of negotiation of meaning initiated by the teacher in line 81 is not ended as she begins an insert expansion. She solicits the students' confirmation of her interpretation which she articulates in the form of conditional with final raising intonation. Her confirmation request may also be regarded as an implicit other-repair of Quim's utterance focused on formal aspects of the target language because her turn contains a subject, a verb with the 3rd person singular final -'s' and a possessive pronoun instead of a definite article (compare her *if it changes its* ↑*shape* and the student's *change the shape*). Once Jaume shortly confirms in line 88 that her interpretation is correct, the teacher gives her personal

⁵ For the analysis and discussion of a similar case resulted in complete misunderstanding and miscommunication between a teacher and a student in L1 science classroom see Lemke (1990: 28-42).

opinion of the topic (**I think so**, line 89) which concurs with the assumption expressed earlier by the students.

After a brief pause, in line 90 the teacher makes a discourse shift from her own perspective ('I') to that of a shared classroom experience ('we'). By referring to their common impossibility to examine the phenomenon of Euglena changing its shape during the experiment, she introduces – though implicitly and in a negative form (**we cannot see it**) – the importance of using pieces of scientific evidence (in this case, an observable one through the physical act of seeing) in the construction of school-science knowledge. Still, the fact of verbalizing the joint difficulty leads to Jaume's open disappointment in L1 (line 91) and Quim's unintelligible utterance (line 92) which thereby close the sequence with a negative assessment.

In lines 94-96 the teacher enacts a series of multimodal actions which seem to contribute to the development of her idea **but we cannot see it today** (line 90):

Excerpt 1.7

93. ***(1.0)**
94. *tea* **looks left and right over desks in first row*
95. **TEA:** **but if you (.) *look ↑here**
96. *tea* **finds reference book, takes it*
97. ***(2.0)**
98. *tea* **looks for something through it*
99. **TEA:** ***Euglena (3.2)**
100. *tea* **continues searching until finds correct page*
101. **TEA:** **is like this**
102. *tea* **fig1.7-a points at image----*
103. *jau,* **fig1.7-a slightly lean forward towards teacher*
qui



*

Figure 1.7-a

104. TEA: (in) this:: (0.7) *fig1.7-b book.



*

Figure 1.7-b

105. JAU: xxxxxxx

106. tea gazes briefly at JAU, then back at image

107. TEA: and your::*

108. tea ----->*fig1.7-c



*

Figure 1.7-c

109. Euglena

110. tea points at image----

111. is not like this (0.5)*

112. tea -----*

113. it's not *fig1.7-d so: long (0.5)

114. tea *moves index finger down and up along image



*

Figure 1.7-d

115. **TEA:** **it's** *^{fig1.7-e}**rounded.**

116. *tea* *circles image with index finger

117. *jau* *makes three circling gestures with index finger



*

Figure 1.7-e

During 1.0 second pause the teacher seems to seek out something, this being evidenced in her head movements and gazes to the left and right over the first row of tables in front of her (lines 93-94). Her utterance **but if you (.) look** ↑**here** in line 95 and her non-verbal actions in lines 96-98 give the students (and us) a first clue about what exactly she has been looking for: she utters **look** ↑**here** while taking an L1 biology reference book which has been given to each pair of students at the beginning of the session and which she finds on the table next to Quim. The fact that the teacher searches something (which results to be a physical artefact, the reference book), then starts her utterance with a contrasting conjunction 'but' and, after a micro-pause, produces 'look here' allows inferring that she opens a new interactional sequence, namely, an explanation, which is nevertheless intrinsically related to her utterance in line 90 in which she has stated their joint difficulty in evidencing the phenomenon in question, that is, the capability of the observed microorganism to change its form.

The teacher employs a verb of visual perception ('look') and a prosodically emphasized deictic ('here') to explicitly attract Quim and Jaume's attention to what she is going to say and/or do next. During the second pause (line 97), and with the artefact in her hands, she starts to look through it in search of something (line 98). She names the studied microorganism (line 99) thus signalling to the students that what she is seeking is relevant for the on-going interaction and they should keep attention to her. Having spent more than 5 seconds in her search, the teacher seems to finally find the page (line 100). Then she ends her utterance with **is like this (in) this:: (0.7) book** and shows an image in the reference book (from her utterance it can be inferred that it is the image of Euglena) to the students while pointing at it (lines 101-102 and 104, Figure 1.7-a).

In the following lines Quim and Jaume to whom the teacher's explanation is addressed display their understanding non-verbally: when the teacher initiates her deictic gesture in line 102 (which will last till line 109) they slightly lean forward towards her (line 103, Figure 1.7-a). The students' (at least Jaume's⁶) and the teacher's coordinated mutual gaze orientation to the image she's pointing at in the reference book (line 104, Figure 1.7-b) can be interpreted as a sign of their joint orientation to the co-construction of a shared understanding. Such reading of the participants' interventions is supported by the course of actions which is being progressively enacted in the on-going interaction, that is, Jaume's (unfortunately unintelligible) utterance in line 105 (a possible comment to the teacher's message or gesture?) and the teacher's momentary re-orientation of her gaze towards him in line 106, thereby acknowledging his contribution, and then back to the artefact.

In line 107 the teacher initiates an elaborated comparison between the image in the reference book and what the students have seen under the microscopes while continuing to point at the former (line 108). In the first place, she relates the last part of her previous utterance **Euglena (3.5) is like this (in) this:: (0.7) book** to what she is going to say next – **your:: Euglena is**

⁶ Due to the location of the camera during that lesson, the participants were shot laterally. The fact that Quim was sitting next to Jaume, namely, on his right, resulted in that on this and other occasions he was 'overshadowed' by the latter in the video recordings. This often highly limited the analysis of Quim's non-verbal actions.

not like this – with the conjunction ‘and’. Moreover, the teacher explicitly and multimodally makes Quim and Jaume’s classroom experience as the observers of the phenomenon under discussion relevant for the comparison she is building first by emphasizing and stretching the pronoun ‘your’ and then through a brief gaze and a deictic gesture at Quim (lines 107-109, Figure 1.7-c). By pointing again at the image while saying that the students’ Euglena **is not like this** (lines 110-112), that is, that what they have observed is different from what is depicted in the reference book, she effectively strengthens her comparison.

After a micro-pause of 0.5 second, the teacher develops further the comparison by overtly explaining the difference between the two Euglenas (see Figure 4.2-5 below). With this aim she provides a description of the students’ Euglena using a syntactic structure *it’s (not)+NP* twice. First she gives a negative description (**it’s not so: long**, line 113) and then a positive one (**it’s rounded**, line 115). To ensure students’ understanding of her message and highlight the importance of academic knowledge being constructed, here again she combines verbal means with non-verbal ones. In the first case, having uttered the first part of the negation, she then produces **so: long** (line 113) and simultaneously moves her right index finger down and up along the image while gazing at Jaume (line 114, Figure 1.7-d). In the second case, again, having uttered the first part of this time positive statement, she then pronounces **rounded** (line 115) while circling the image with her finger (line 116, Figure 1.7-e). It can be seen hence that each time the teacher effectively reinforces her verbal message in the target language by aiding it visually with an iconic gesture.

Concurrently to the teacher’s gesture in line 116, Jaume also makes three rapid circles in the air with his index finger (line 117, Figure 1.7-e). By producing the same non-verbal action synchronically with that of the teacher, he skilfully displays his understanding of the explanation that the teacher has developed up to that point and also actively contributes to its on-going construction in interaction.



Figure 4.2-5. 'Euglena can change its shape': round-shaped and long-shaped Euglenas

Source: Bloc created by Mònica Cobas, a science teacher

INS Torrent de les Bruixes (Sta. Coloma de Gramenet, Spain)

Available at: <http://cntorrentdelesbruixes.blogspot.com.es/2009/02/euglena-planta-o-animal.html>

Let us now move to Excerpt 1.8, the last one in interactional project 1:

Excerpt 1.8

118. TEA: ↓so (0.5) *^{fig1.8-a}what does it mean?



*

Figure 1.8-a

119. QUI: ↑change the shape

120. tea nods

121. TEA: it can change shape.

122. JAU: però no no constant↓ment (.) ↑clar==

Translation: but not not constantly (.) of course

123. TEA: =no.

Translation: no

The teacher's use of the discourse marker 'so' in line 118 is characterized by a strong emphasis, a falling pitch and the marker's separation from the subsequent part of the utterance by a 0.5 second micro-pause. All this clearly indicates the end

of a prolonged sequence in which the teacher and the students have dialogically developed the explanation which evidenced the difference between the two Euglenas. At the same time it can also be assumed that the teacher employs the marker as a means to relate what she is going to say to the preceding sequence as its logical inference. More particularly, that she is probably going to tender the students a recapped and final answer to their initial problem of concluding whether the studied microorganism can change its shape or not. However, she does not do it but instead addresses Quim and Jaume with a question **what does it mean?** Such teacher's action of officially passing them the interactional floor and positioning them as legitimate co-constructors of knowledge claims is accompanied by her 'inviting' gesture with an arm oriented to the students and a palm half-open (line 118, Figure 1.8-a).

The establishment of a mutual gaze between the teacher and Quim during the statement of the question allows him to be the first one to contribute to the co-constructed inference and provide a candidate response. Quim does it repeating his utterance **change the shape** (line 119) which he has already proposed on several occasions as both a question and a potential answer (see Excerpt 1.1). He does it however with a rising intonation thus implicitly requesting the teacher's confirmation.

The teacher legitimates his candidate response with a nod (line 120). In the next line she adds a post-expansion in which she reformulates his utterance into a complete clause **it can change shape** (line 121), thereby finally officialising it as a scientifically accepted statement. Here again, as it has been noted before (see Excerpt 1.1, line 81 and Excerpt 1.7, line 87), the teacher's turn may also be interpreted as an integrated, that is, linguistic and content-related, other-repair of the student's utterance. On the one hand, she incorporates a formal L2 element such as a subject and eliminates another one, the article, and, on the other, adds a modal verb 'can' which allows her to highlight the *capability* (but not the obligation) of the studied microorganism to change its form. In this way the teacher overtly models the appropriate way of talking school-science in the target language.

Jaume's following-up logical reasoning in the L1 (*però no no constantment* (.) ↑*clar-*, line 122) that the microorganism obviously cannot change its form constantly is acknowledged by the teacher with a short sequence-closing third in the form of emphatic no, also in the L1 (line 123). Both students' interventions can be legitimately regarded as their public displays of their new, interactionally acquired, knowledge (Koole, 2010) as well as their contributions to the co-construction of school-science accountable talk.

Two final analytic observations may be made. In the first place, Quim's interventions – though consisting of the same wording 'change the shape' throughout the whole interactional project – show him successfully recycling the subject-specific content provided, that is, the original statement from the handout 'Euglena can change its shape'. In the second place, it is worth noting that the teacher does not confirm his initial assertion until the very end of the interactional project, until she is not sure that both students have understood the phenomenon, the latter being evidenced in their contributions to the joint construction of the explanation.

4.2.2. *Summary and discussion*

A fine-grained analysis of the four Excerpts (1.1 and 1.6-1.8) comprising interactional project 1 has revealed several important features of the process of meaning making and the co-construction of dialogic explanations in the observed CLIL science classroom.

First of all, it needs to be highlighted that *the process was launched by the two students* who faced difficulties in confirming or refuting the statement 'Euglena can change its shape' by basing exclusively on their observation of the (absence of the) phenomenon and who finally decided to resort to the officially recognized expert in the classroom, the teacher. The process may be summed up as a series of actions:

1. The students publicly state the problem;
2. The teacher initiates the sequence of the negotiation of meaning by providing the scientific meaning of the lexical item used by Jaume;

3. The students make explicit their own understanding of the item;
4. The teacher uses a change-of-state token to mark her previous misunderstanding and solicits confirmation;
5. Jaume provides the requested confirmation thereby closing the sequence of the negotiation of meaning;
6. The teacher initiates the explanation of the phenomenon which provoked the students' problem;
7. The students contribute multimodally to the co-construction of the explanation;
8. Once the dialogic explanation has been developed, the teacher and the two students jointly construct a final inference by recycling the original statement which has triggered the whole interactional project and in this way efficiently solve the students' problem.

Figure 4.2-6 below presents this dialogic explanation of the differences between the image of Euglena in the reference book and the microorganism's shape which the students observed in the experiment which has been interactionally and multimodally co-constructed by several voices:

TEA: but if you (.) **seizing gesture -> reference book** look here (2.0) **searching gaze -> reference book** Euglena (3.2) is like this **pointing gesture -> image in reference book** JAU: **leaning forward -> TEA** QUI: **leaning forward -> TEA** TEA: (in) this:: (0.7) book. **gaze -> image** JAU: **gaze -> image** xxxxxx TEA: **brief gaze -> JAU** and your:: **pointing gesture -> QUI + gaze -> QUI** Euglena is not like this (0.5) **pointing gesture -> image** it's not **'down and up' gesture -> image + gaze -> JAU** so: long (0.5) it's **circling gesture -> image** JAU: **circling gestures in air** TEA: rounded.

Figure 4.2-6. Dialogic explanation co-constructed in Excerpt 1.7, lines 95-117

Through a detailed analysis it has been identified and described how the teacher sequentially intertwined linguistic and paralinguistic elements which constituted her verbal message with numerous non-verbal actions in the process of elaborating the explanation (see Figure 4.2-6 above). She mobilized an array of

multimodal resources: language (e.g., morpho-syntax, lexis) and its different textual genres (comparison and description); prosodic elements of intonation, stress and stretching; pauses; gaze and gesture; and material objects (the reference book and the image in it). Such rich multimodality allowed her to afford students access to academic knowledge which she and the students used in order to jointly develop a shared understanding of the phenomenon of shape-changing.

More particularly, she evidenced a mismatch between the students' empirical findings based on their observations of the studied microorganism and the school-science artefact, the reference book, recognized as one of the official sources of scientific knowledge in the classroom. Second, she explicitly guided the students in learning that empirical data – which in this case were their findings in the experiment – need to be always checked against knowledge already accepted in the scientific community as well as to always correlate credited sources of knowledge – in this case, the reference book – with the obtained empirical data. And finally, she modelled how to talk school-science in the target language rigorously, that is, how to construct school-science knowledge through the L2 academic discourse in the form of, for example, an explanation by establishing explicit relationships between an empirically observed phenomenon or characteristic (or, in this case, its absence) and a credited source of knowledge (in this case, the reference book).

Such teacher's actions aimed at the co-construction of shared understanding of relevant empirical and academic knowledge and ultimately at scaffolding the students' learning of school-science are evidenced in the way she carefully and skilfully led the students through the explanation.

When turning to the two students who participated in this interactional project, the analysis has portrayed them to be 'situated competent' within this context since they effectively employed linguistic and other semiotic resources available to them and accomplished sophisticated interactional moves in doing school-science. More particularly, they skilfully (and multimodally) stated scientific problems, negotiated meanings, displayed their understanding and knowledge as well as contributed to the co-construction of new shared

understandings and appropriate school-science claims, all of these being relevant social practices within the CLIL science classroom CoP. It has also been observed that the students felt comfortable enough in this CLIL science classroom to treat the target language creatively in the process of learning to talk like school-science practitioners. In the data corpus this has been evidenced in the way how Jaume ingeniously generated two similar L2 terms ‘metamorphil’ and ‘metamorphinaplus’ as well as appropriately employed an L1 existing reification ‘*metamòrfica*’.

4.3. INTERACTIONAL PROJECT 2: *LIKE A WHIP*⁷

4.3.1. Analysis

This interactional project also occurs during activity 2.1, two minutes after Excerpt 1.8 analysed in section 4.2.1. The participants are the teacher, a participant observer (Xenia, XEN), and four students (Quim, Jaume, Marta, MAR and Arnau, ARN). Quim and Jaume form one pair; Arnau belongs to another pair while Marta works with two more students in a triad. Figure 4.3-1 presents their spatial distribution in Laboratory 2.

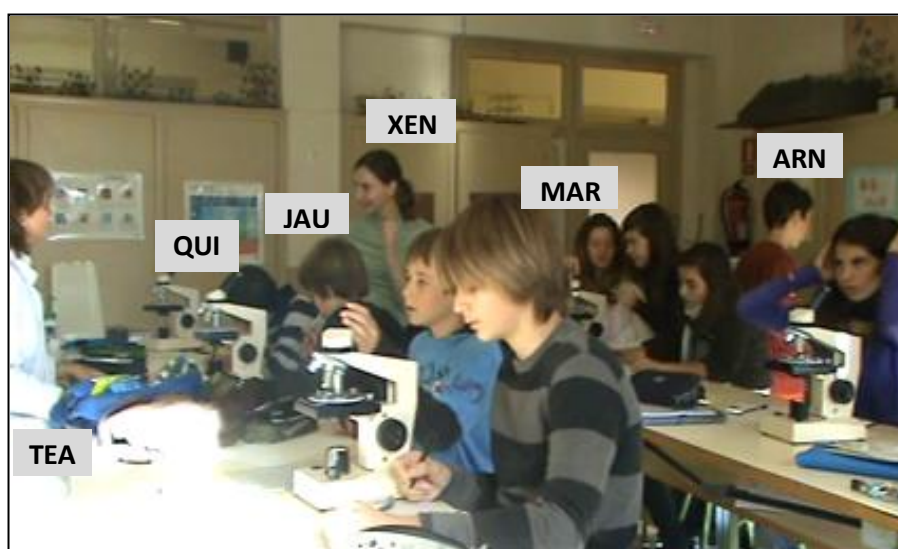


Figure 4.3-1. Spatial distribution of the participants in interactional project 2
(Figure corresponds to Excerpt 2.1, line 231)

⁷ A shorter and less developed version of the analysis presented in this section was published in Evnitskaya and Morton (2011).

Interactional project 2 is comprised by three Excerpts which sequentially show the participant observer announcing that Marta and her two partners have found Euglena with a flagellum (an element which allows the microorganism to move, see Figure 4.3-2 below) which is acknowledged by the teacher (Excerpt 2.1). Once the teacher approaches the participant observer and the students, they report their finding and the teacher checks it under the microscope and confirms the finding (Excerpt 2.2). After that, the teacher publicly announces the students' discovery to the rest of the class and initiates an explanation of the phenomenon of moving. Two students (Jaume and Quim) actively contribute to its co-construction (Excerpt 2.3).

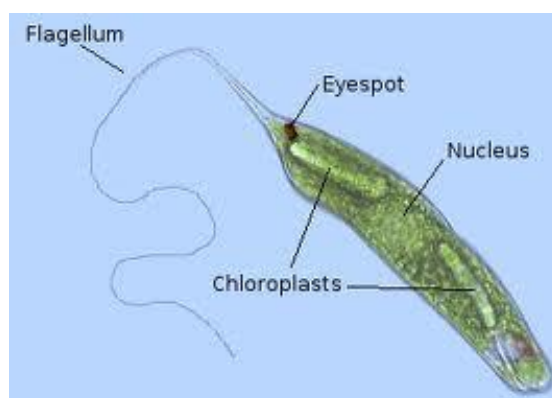


Figure 4.3-2. An image of Euglena with a flagellum

Source: Mount Logan Middle School (Logan, Utah, USA)

Available at:

http://www.mlms.loganschools.org/~ckircalli/homework/MATH_SCIENCE%20LINK%20PAGES/PROTIST%20INTERNET%20LESSON.html

Excerpt 2.1 starts when Xenia, a researcher and participant observer, reports to the teacher that the group of three students situated at the back of the classroom and whom she has been helping with the on-going activity of checking the statements from the handout has 'found one [Euglena] with the tail':

Excerpt 2.1

231. **XEN:** **we've found one with the tail.**
232. **TEA:** **a↑ha**
233. ***(3.0)**
234. *tea* **goes to group at the back of classroom*

235. TEA: with the flagellum?
236. MAR: flagellum
237. TEA: this is flagellum=
238. MAR: ↓yes
239. TEA: =(then it is-)

In line 231 (see also Figure 4.3-1 above) Xenia produces what can be considered an action of ‘telling’ (Schegloff, 2007) thereby initiating an ‘announcement sequence’. The teacher reacts with a↑ha (line 232), an expression of ‘newsworthiness’, thus acknowledging the contribution in the previous turn but she does not close the sequence with her turn. Rather, she moves to the back of the classroom towards the group (line 234) and begins an insert expansion in which she requests the confirmation of what has been reported (line 235). Still, she doesn’t literally repeat Xenia’s utterance but rather reformulates it by replacing an everyday word ‘tail’ with a more appropriate scientific reification ‘flagellum’. In this way the teacher *gradually orients* the classroom discourse to being more academic.

This sequence is noteworthy in two ways. First, because it is one of the students from the triad, Marta, who provides the requested confirmation to the teacher in line 236 and not Xenia, the initial reporter. And second, because Marta does it by recycling the proposed term ‘flagellum’. Her action may be interpreted as her alignment with the teacher in the orientation to school-science language. Such orientation is also evidenced in the teacher’s turn: she incorporates the student’s single-word confirmation into a specific syntactic format *it is/this is+X*, where [X] is a scientific term or concept (Pekarek Doehler and Ziegler, 2007), thus supplying the students with another relevant reification – this time a syntactic construction – in the L2.

Marta’s short affirmation in line 238 (↓yes) contributes to the joint negotiation of meaning since it enters the teacher’s turn as a second voice without actually taking the interactional floor. Her intervention can be interpreted as both her acceptance of the teacher’s action of modelling an appropriate way of talking school-science in the CLIL classroom CoP and her confirmation of the fact that they

share understanding of what exactly is the topic under discussion. Assuming that the teacher's **then** means 'so' (line 239) leads to the interpretation of her unfinished utterance **then it is-** as a logical causal development of **this is flagellum** (line 237), embedded into the same syntactic format.

Once the teacher has joined the group, both Xenia and Marta show her their discovery:

Excerpt 2.2

240. *tea* *addresses another student, probably Gemma*

241. **TEA:** **I'm sorry (.) one moment.**

242. **XEN:** **it's on the right.**

243. *xen* *points at microscope----*

244. **MAR:** ***(ja està) aquí.**

Translation: it's here

245. *mar* **fig2.2-a* *points at microscope*



*
Figure 2.2-a

246. **XEN:** ***it's here.***

247. *xen* *----->**

248. *mar* **fig2.2-b* *points again at microscope*



*
Figure 2.2-b

249. * (5.0)

250. tea *fig2.2-c



*
Figure 2.2-c

251. **TEA:** **a:** ↓sí ↑o::h (1.5) **yes yes yes (.)**

Translation: oh: yes

252. **very** ↓good

253. **(3.0)**

It is again Xenia who starts a new sequence of reporting: she indicates the exact location of the microorganism on the slide both verbally in the target language (*it's on the right*, line 242 and *it's here*, line 246) and non-verbally through a prolonged pointing gesture at the microscope (lines 243 to 247). In her turn, Marta employs the same semiotic resources, that is, language and gesture, to contribute to Xenia's reporting. First she utters (*ja està*) *aquí* ('it's here', line 244) in the L1 while using a deictic gesture (line 245). Then she repeats the gesture in line 248 during Xenia's second utterance.

Xenia's prolonged gesture and Marta's repeated pointing may be explained by the fact that when Xenia initiates the reporting the teacher is still approaching them (compare the teacher's position in Figures 2.2-a and 2.2-b) and therefore at that moment is not able to see where exactly they are pointing at. Through their multimodal actions these participants effectively *connect* the act of locating *Euglena* verbally to a physical artefact, a microscope. This artefact is thus introduced into interaction as a necessary and significant mediating tool which allows the teacher to check the group's claim in lines 249-250 (Figure 2.2-c).

The teacher's demonstration of understanding in line 251 begins with a news-receipt, at first in Catalan/Spanish (**a:** *sí*) and then in English (↑o::h (1.5))

yes yes yes). It contains a token 'oh', thereby denoting the receipt of all the information that the sequence has been initiated for and suggesting the closing of the latter. The teacher's multiple saying of 'yes' (Stivers, 2004) within the same turn also confirms this interpretation. Being a common meaning-making resource, multiple sayings are used when speakers want to show that 'their talk is addressed to a larger course of action rather than only to the just prior unit' (Stivers, 2004: 288). Here, the teacher's use of the token 'oh' and her multiple saying of 'yes' can be seen as a base second-pair part of the adjacency pair within the announcement sequence started by Xenia's telling in line 231 (Excerpt 2.1). In line 252 the teacher adds a sequence-closing third in the form of a positive assessment (**very ↓good**). That the sequence is indeed closed may be confirmed by a 3 second pause in line 253.

This pause does not imply however that *all* participants implicitly agreed that the topic under discussion was cleared up and therefore the episode (Excerpts 2.1 and 2.2) was ended. In line 254 the focus shifts to the rest of the students – the teacher wants to attract their attention to the finding made by Marta's group:

Excerpt 2.3

254. *tea addresses class*
255. **TEA:** ↑**here**
256. *** (1.5)**
257. *tea *moves to front*
258. **TEA:** **they they have found (.)**
259. **a Euglena wi:th a lo:ng ↑hai:r * (1.0)**
260. *tea *draws on board*
261. **with a long hair.**
262. **what does this mean?**
263. **MAR:** ↓**flagellum**
264. **(1.5)**
265. **ARN:** ↓**flagellum**
266. **TEA:** **this means that this organism can move (0.5)=**

267. **JAU:** ↓yes
268. **TEA:** =because when it-
270. *fig2.3-a (0.3) fig2.3-b mm: fig2.3-c like this-fig2.3-d like a fig2.3-e whip
269. tea *with right hand makes ten short quick waving movements----
271. jau *with right hand makes two rapid movements of something
272. going away very fast----



Figure 2.3-a



Figure 2.3-b



Figure 2.3-c



Figure 2.3-d



Figure 2.3-e

273. **JAU:** *fig2.3-f, va*

Translation: go

274. tea ----->*

275. jau ----->*



Figure 2.3-f

276. **TEA:** como un-

Translation: like a-

277. qui *fig2.3-g takes reference book



*

Figure 2.3-g

278. **QUI:** (like) *unos flagelados aquí.*

Translation: some flagellated here

279. **TEA:** *por eso.*

Translation: that's why

280. *qui* *fig2.3-h *points at something in reference book,*

281. *probably the organism's name or class and its image*



*

Figure 2.3-h

In lines 254-257 the teacher calls for the attention of the class to the finding made by Marta's group. She does it employing different meaning-making resources: verbal, by addressing the students in the L2, paralinguistic, by raising intonation, and non-verbal, by moving to the front of the classroom. In the following lines (258-261) the teacher publicly announces the discovery thus *officialising* it as a scientifically accepted contribution and making it *publicly accessible to the whole class*. Excerpt 2.1 has already shown the teacher's orientation to more school-science discourse which was evidenced in her replacement of Xenia's 'tail' with 'flagellum'.

This time however she chooses 'everyday' wording to reify Xenia's initial telling *we've found one with the tail* from line 231 into *they they have found (.) a Euglena wi:th a lo:ng ↑hai:r*. It is noteworthy that besides the

formal grammatical changes (the use of the 3rd person plural and the full verbal form instead of the contraction) which are partially required by the fact of reproducing the other person's words, the teacher also substitutes 'one' (only understood in the local context of Marta's group) for the microorganism's name and 'tail' for 'long hair', the latter being a more appropriate and precise descriptor of the flagellum's size and volume.

Here again the teacher employs rich multimodality: first, she emphasizes the key words by sound stretching (**wi:th a lo:ng hai:r**) (line 259). Then she accompanies her utterance with a physical act of drawing the 'hair' in the image of Euglena on the board (line 260). And finally, she repeats the utterance, this time with a normal rhythm but with a falling intonation on 'hair' (line 261). So, she incorporates paralinguistic and non-linguistic elements to *reinforce* her verbal message in the L2. All this let us infer that even though the teacher preferred to use everyday language in the message, her relay on diverse meaning-making resources in carrying it out was influenced by the need to guarantee the students' understanding of the message.

Such assumption is corroborated by the teacher's overt question in line 262: **what does this mean?** where 'this' clearly makes reference to the observed scientific phenomenon. Marta (line 263) and 1.5 second later Arnau (line 265) offer a candidate answer: **flage11um**. Their interventions portray them acting as school-science practitioners within this classroom CoP: they employ the academic term that has been introduced by the teacher in Excerpt 2.1, display their knowing and self-position as the authors of knowledge claims. Yet, the teacher neither accepts nor rejects their contributions⁸; she simply provides her own answer (line 266).

A possible explanation could be that the students' response is not the *expected* (and therefore dispreferred) one. Both Marta, who participated in the

⁸ At least verbally. It is impossible to say whether the teacher reacted in any non-verbal way (by gesturing or changing body position / face expression) since during the lesson the camera was placed to shoot primarily student interaction in groups and, hence, the angle with the teacher at the board mostly resulted to be blind.

previous private news-announcement sequence with the teacher (Excerpt 2.1) and therefore already knew the term, and Arnau, who could hear her saying it, merely label the observed phenomenon by using a corresponding subject-specific reification. It may be that the teacher, by designing a *Wh*-question, expected them to relate the term to the academic knowledge they had already acquired about living things and their vital characteristics through a causal logical relation. The same wording of the question with which she starts her utterance, the very causal relation she establishes in it (**this means that this organism can move**) and her emphasis on the last word, all sustain such interpretation.

However, the same arguments can be advanced for another possible reading of the teacher's actions: the question may have been a rhetorical move preceding the teacher's explanation and as such required no answer from the students. Whatever the reason, the fact is that the teacher establishes a logical relationship and replaces a concrete name 'Euglena' – which represents a living thing from a concrete species – with a more generic biological reification 'organism'. This substitution may be understood as an indication of her *guiding* the students in the process of abstraction through generalization, both being distinctive characteristics of biology and other empirical sciences.

In line 268 the teacher seems to have a problem in finding appropriate wording to convey the idea of a specific kind of movement produced by the flagellum. To overcome it, in what follows she creates a notable interdependency between verbal and non-verbal actions. She employs an iconic waving gesture consisting of approx. ten short quick movements with her right hand (lines 269 and 274, Figures 2.3-a to 2.3-f) to express what she has been unable to articulate linguistically thus compensating for the missing word with a gesture. At the same time, after some hesitation, a failed attempt and repetition, all of which reflect the 'on-spot' process of word search (Kurhila, 2006), she finally finds an English word 'whip' (**mm: like this- like a whip**, line 270). This word, ingeniously borrowed from everyday discourse, may however result to be unfamiliar to the students due to its little (or no) use in their CLIL and EFL classrooms' repertoire and its lack of similarity to the students' L1 (i.e., '*látigo*' in Spanish / '*fuet*' in Catalan). Hence, the teacher's prolonged gesture temporally coordinated with talk can be interpreted

as a visual support and a mediating tool that helps her illustrate the word's meaning⁹.

CA-oriented research¹⁰ has shown that on occasions, when the current speaker faces a (communicative or cognitive) problem, devices such as cut-offs and sound stretching combined with gaze and gesture can be used to solicit co-participation in interaction¹¹. If such multimodal 'invitation' to participate is accepted – which often occurs through the other participant's self-selection as a possible next speaker – then the activity of solving a problem becomes a collective enterprise.

This seems to be precisely the case of Jaume who, concurrently to the teacher, accomplishes two rapid iconic gestures in lines 271-272 and 275 (Figures 2.3-a to 2.3-f). His gestures seem to represent 'something going away very fast' and, followed by the L1 word '*va*' ('go') in line 273, reveal his attempt to express how the flagellum moves (or at least, how it helps Euglena to move). They also evidence his co-participation in making interaction progress and bringing the teacher's difficulty to explain such movement to its solution. However, unlike the teacher, Jaume shifts from the use of non-verbal to verbal resources. His actions can even be interpreted as his display of understanding of the teacher's statement about Euglena's ability to move from its very announcement (line 266) since it was him who confirmed it (line 267).

Line 276 reveals that the teacher continues seeking an appropriate term which would allow her to clarify the (potentially) problematic concept through comparison. At this moment it turns out that Jaume is no longer the only student who displays understanding of the teacher's (verbal and/or non-verbal) explanation. Quim seems to have caught the teacher's idea expressed in her gesture as he joins the unfolding talk and displays understanding through his own

⁹ 'Whip' is the English word for 'flagellum' (Latin).

¹⁰ See e.g., Goodwin (2003); Heath (1992); Kendon (2004); Mondada (2007).

¹¹ Heath (1992) also argues that sometimes a gesture, for example, an iconic one, may be actually used simultaneously to illustrate some semantic aspect of the speaker's talk and to elicit recipients' co-participation.

non-verbal actions. Namely, he takes an L1 biology reference book – which contains information on different microorganisms in Catalan and their images – and, still merely referring to it, uses it as a resource to complete the teacher’s unfinished comparison by suggesting (like) *unos flagelados aqui* (lines 277-278, Figure 2.3-g).

Quim’s intervention shows a variety of multimodal meaning-making resources which he draws on in accomplishing his new discourse role of the co-creator of a relevant scientific claim. Having initiated his contribution in the target language (English), he nonetheless switches to Spanish (perhaps because the teacher’s unfinished utterance is in this language) in order to convey his idea effectively. However, rather than sticking to a familiar and easily comprehensible everyday word-selection in the L1, Quim produces a highly specific biological reification – a generic lexical item which names a diverse group of eukaryotic microorganisms with a flagellum.

More particularly, he inserts this L1 reification ‘*flagelados*’ between the initial, contextually-sensitive recycling of the teacher’s wording (‘*como un*’ vs ‘like *unos*’) and the final L1 deictic ‘*aqui*’ (‘here’). Hence, he uses it as a key element that allows him to successfully link together three other relevant and interactionally constructed artefacts: the teacher’s causal explanation, her and Jaume’s iconic gestures and the reference book he (i.e. Quim) has in his hand. Such complex intervention of Quim can be considered the result of the *situated learning* in this classroom’s CoP. It is based on the explanation provided, but even more importantly on the visualization of the problematic concept through the teacher’s gesturing. It is also tightly linked to another current collective enterprise, namely, the observation of *Euglena* under the microscopes.

Being encouraged by the teacher’s confirmation in the L1 in line 279 (*por eso*, ‘that’s why’) and in order to validate his claim with a piece of scientific evidence, Quim then directly addresses the reference book with a deictic gesture. More particularly, he seems to point at the name or class of living beings that have such a characteristic and at a corresponding image (lines 280-281, Figure 2.3-h), in this way closing interactional project 2.

Quim's actions can be summed up in the following way: first, he employs the L1 reification which results to be appropriate for the unfolding talk. Second, he relates it to the teacher's and Jaume's verbal and non-verbal actions. And finally, he establishes an explicit verbal and physical (through gesture) connection between the used term ('flagelados') and the inscriptions in the reference book. Through such series of actions he publicly and multimodally displays to the teacher his new, interactionally acquired, knowledge and, moreover, contributes to the co-construction of the school-science claim.

4.3.2. Summary and discussion

Having carried out an in-depth exploration of the three Extracts that make up interactional project 2 let us now proceed to the discussion of the findings.

The analysis has revealed that the co-construction of shared knowledge, mainly through the dialogic explanation, was carried out through the chain of interactional moves which can be broadly characterized as follows:

1. The participant observer (Xenia) announces the students' finding.
2. The teacher acknowledges her initial reporting and solicits confirmation.
3. One of the students from the group (Marta) provides the requested confirmation.
4. Xenia and Marta multimodally accomplish a more contextualized report of their finding: they situate it spatially and relate it to the material artefact (the microscope).
5. The teacher marks the news-receipt through a change-of-state token 'oh' and multiple sayings ('yes') and provides positive feedback on their reporting.
6. The teacher publicly announces the group's discovery to the rest of the class.
7. The teacher states a question to check the students' understanding.
8. Two students (Marta and Arnau) provide their candidate answers.

9. The teacher does not acknowledge the students' answers but rather initiates the explanation of the phenomenon which lies behind the students' finding reported by Xenia and Marta.
10. The teacher experiences difficulties in constructing the explanation using only linguistic means and employs gestures to support her verbal message.
11. Two students (Jaume and Quim) actively and multimodally contribute to the co-construction of the explanation by making use of gestures, talk and material artefacts.

Comparing the two interactional projects analyzed up to now, it can be seen both were *initiated by other participants than the teacher*: the students in the first case and the participant observer who collaborated with a group of students in the second.

It has also been observed that in accomplishing their situated actions the interactants constantly moved forward and backward between academic discourse (in both the L2 and the L1) and everyday discourse (see Figure 4.3-3 below). This allowed them to collectively construct a complex semantic network of school-science reifications and everyday lexical items, namely, 'flagellum' and '*flagelados*', and 'tail', 'hair' and 'whip', respectively. In this network each of these words contributed to shed light on the meaning of the others as well as served as a 'building block' in the joint construction of shared understandings and relevant academic knowledge.

XEN: **tail** (line 231) -> TEA: **flagellum** (line 235) + MAR: **flagellum** (line 236) -> TEA: **long hair** (line 259) -> MAR: **flagellum** (line 263) -> ARN: **flagellum** (line 265) -> TEA: **whip** (line 270) -> QUI: **flagelados** (278)

Figure 4.3-3. Semantic network co-constructed in interactional project 1

It needs also to be mentioned that even when the teacher employed a more everyday language in announcing the students' finding to the rest of the class (Excerpt 2.3), she yet has been seen to follow one of the established norms of accountable school-science talk, that is, precision in the use of terms and

underlying concepts, thereby providing one more example of educated discourse to the students.

Let us now go through the whole explanation of Euglena's ability to move thanks to flagellum which has been dialogically co-constructed by the teacher and the students (Figure 4.3-4):

TEA: this means that this organism can move (0.5)= JAU: ↓yes TEA:
=because when it- *waving gesture* JAU: *waving gesture* TEA: (0.3) mm:
like this- like a whip JAU: ↑va TEA: como un- QUI: *seizing gesture ->
reference book* QUI: (like) unos flagelados aquí. TEA: por eso. QUI:
pointing gesture -> inscription/image in reference book

Figure 4.3-4. Dialogic explanation co-constructed in Excerpt 2.3, lines 266-281

The detailed analysis of interactional project 2 has shed light on the way the teacher mobilized a range of multimodal resources (language, prosodic aspects and non-verbal elements) in order to negotiate and construct, in a private interaction with these students, a shared understanding of their discovery of Euglena with a flagellum. She also employed such resources in whole-class interaction in order to introduce key concepts, establish logical relationships between the students' finding and academic knowledge about living things as well as to construct more abstract and general meanings appropriate of school-science.

The teacher also skilfully interweaved verbal and non-verbal meaning making devices to successfully solve her difficulty in explaining the movement of a flagellum. By employing an everyday word 'whip', which yet could result unknown to the students, and a concurrent waving gesture she both made her verbal message more visual and comprehensible and was able to make the explanation progress.

In regard to the students, the detailed examination of Excerpts 2.1-2.3 has evidenced several issues noteworthy to be discussed. First, the students mobilized a range of multimodal resources (e.g., language, gesture, gaze) in displaying their understanding of the teacher's (verbal and non-verbal) explanations. Second, they efficiently and multimodally introduced relevant material artefacts (e.g., microscope, reference book) into interaction in order to later use these as

mediating tools for the co-construction of the dialogic explanation in progress. And finally, they appropriately and effectively employed academic discourse both in the L1 and the L2 (even though at the level of individually used terms) in displaying their knowledge and making their talk accountable to the teacher's multimodal explanations, relevant academic knowledge and the material artefacts present in the classroom.

4.4. INTERACTIONAL PROJECT 3: *WE'VE BEEN HEATING IT SO MUCH, IT'S DEAD*

4.4.1. Analysis

Interactional project 3 takes place during a final class plenary (activity 3.1). The participants are the teacher and four students (Andrew, Sara, Marta and Arnau). Sara, Marta and one more student (Carla, CAR) work together in a triad. As for Arnau and Andrew, each forms part of a different pair. Figure 4.4-1 presents their spatial distribution in Laboratory 2.

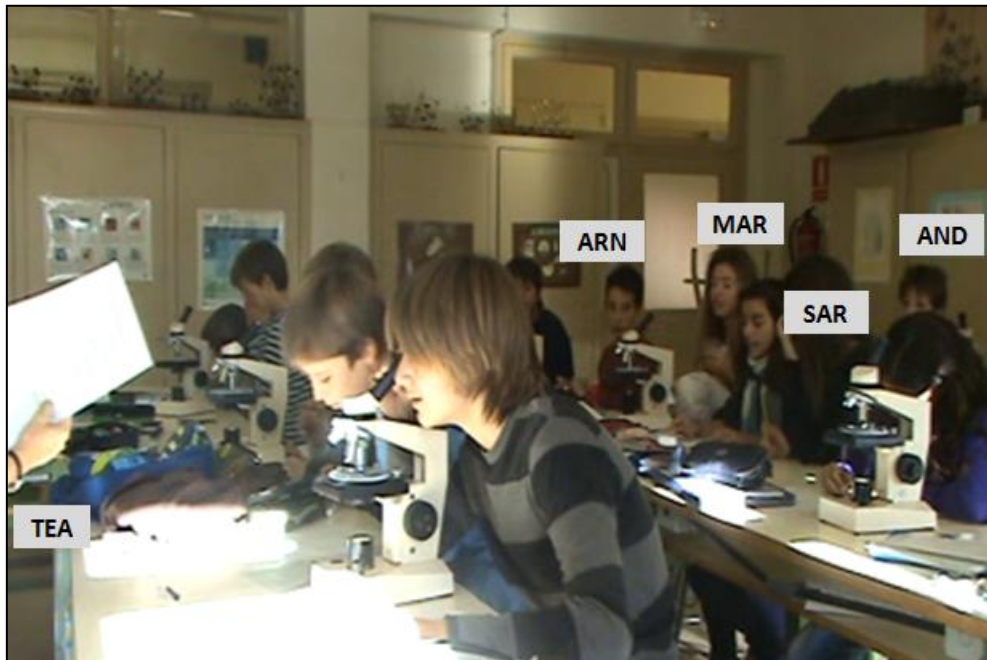


Figure 4.4-1. Spatial distribution of the participants in interactional project 3
(Figure corresponds to Excerpt 3.1, line 509)

Interactional project 3 is divided into four Excerpts¹² which show how Andrew, being nominated by the teacher, reads aloud one of the statements from the handout (see section 4.1, Figure 4.2-1) which he and his partner have been able to examine during the experiment. The teacher accepts his contribution and expands it by relating the students' findings to the already studied knowledge on living things. In parallel, Marta and Sara attempt to get the teacher's attention in order to report their new finding (Excerpt 3.1). Once the teacher has finished her intervention, she nominates Marta who finally announces what her group has found (Excerpt 3.2). Since their finding does not relate directly to the current activity, the teacher opens a sequence of the negotiation of meaning. Several students actively participate in the process of constructing a shared understanding with the teacher which results in the elaboration of a dialogic explanation (Excerpts 3.3 and 3.6).

Excerpt 3.1 starts with the teacher nominating one of the students, Andrew:

Excerpt 3.1

486. **TEA:** e:: ↑**Andrew**
487. **AND:** **yes?**
488. **TEA:** **another observation?**
489. **AND:** e:m:: (1.0)
490. *and* *reads
491. *the chloroplasts allow (.) it to make photosynthesis.
492. *sar* fig3.1-a looking into microscope, raises hand



Figure 3.1-a

¹² Excerpts 3.1-3.3 and 3.6. Excerpts 3.4 and 3.5 are given as complementary data to support the argument being developed in the analysis.

493. **TEA:** **yes.**

494. **you have seen** ↑**chloroplasts**

495. *mar* ***fig3.1-b** *looking into her notes, raises hand*



*
Figure 3.1-b

496. **TEA:** **and we** ↑**know** (1.8)

497. **that** ***chloroplasts** (1.0) **ha:ve the** ↑**function**

498. *mar* ***fig3.1-c** *looks into the microscope*



*
Figure 3.1-c

499. **TEA:** **of making** ***the the food=**

500. *mar* ***fig3.1-d** *gazes at TEA, raises hand*



*
Figure 3.1-d

501. **MAR:** ***fig3.1-e** **we we-**

502. *mar* **points at microscope----*

503. *sar* **raises hand----*



Figure 3.1-e

504. **TEA:** =of the ↑organism*
505. *mar* ----->*
506. *** (1.0)**
507. *sar* *slightly stands up with hand raised----
508. **MAR:** we see thing*
509. *sar* ----->*
510. **TEA:** through [the ↑process of photosynthesis.
511. **MAR:** [xxxx the thi:ng (.) is a-
512. *sar* *reads *
513. **SAR:** *is (sensitive)* to the ↓temperature

After the teacher's nomination in line 486, Andrew produces a short **yes?** (line 487). This interactionally appropriate (preferred) second-pair part, results yet a 'dispreferred' one from the viewpoint of the on-going whole-class activity which implied the students' reporting of those statements with the characteristics of *Euglena* which they have been able to observe during the experiment. Andrew hence does not do what is expected from him as his 'yes' can be interpreted as a clarification request. The teacher provides it by specifying what he has been nominated for (**another observation?**, line 488). In lines 489-491, after a hesitation and a notable pause of 1.0 second, Andrew finally officially reports his group's 'observation' by reading a corresponding statement (see Figure 4.4-2 below).

The chloroplasts allow it to make photosynthesis

Figure 4.4-2. Statement reported by Andrew in Excerpt 3.1, line 491

In line 493 the teacher provides positive feedback on Andrew's intervention, thus closing the reporting sequence. However, in line 494 she initiates a prolonged expansion of the student's public reporting. First, she states the students' experience as the observers of the phenomenon (*you have seen ↑chloroplasts*, line 494). Then she employs a conjunction 'and' to introduce a 'we' statement which contains an emphatically marked verb 'know' (*and we ↑know*, line 496). These three words allow her to explicitly relate the students' empirical findings to their (the students and the teacher's) common subject-specific knowledge (co-)constructed earlier in this classroom CoP. In lines 497, 499, 504 and 510 the teacher exposes that shared academic knowledge: *chloroplasts (1.0) ha:ve the ↑function of making the the food= [...] =of the ↑organism through the ↑process of photosynthesis.*

It may be suggested that through such elaborated recapping the teacher wants to make certain school-science knowledge, which has already been co-constructed with individual students in private interactions, public, accessible to and shared among all. At the same time, the teacher also seems attempting to guarantee the students' understanding (and, moreover, in the target language) of a particular scientific phenomenon, that is, photosynthesis. So, she produces an example of school-science discourse in the L2. Apart from incorporating the key subject-specific reifications already mentioned by Andrew ('chloroplasts' and 'photosynthesis'), she employs four more terms ('function', 'food', 'organism' and 'process'), which help her to build a complex, multi-level and highly nominalized statement 'Chloroplasts have the function of making the food of the organism through the process of photosynthesis'. Hence, the teacher affords the students both an example of what is considered relevant school-science knowledge and how it should be talked into being in the L2.

Meanwhile, Marta and one of her group mates, Sara, show signs of carrying out a parallel activity throughout lines 492-513. So, initially, both students silently orient themselves to the material artefacts to confirm something: they look into the microscope one after the other (Sara in line 492, Figure 3.1-a, and Marta in line 498, Figure 3.1-c) and check their notes (Marta in line 495, Figure 3.1-b). Simultaneously, they make use of a gesture which has been traditionally employed

in classrooms to attract the teacher's attention, that is, hand-raising (Sara in line 492 and Marta in line 495). In the following lines Marta employs the same gesture but this time directly self-orienting towards the teacher through her gaze (line 500, Figure 3.1-d).

It seems that their attempts to take the interactional floor through hand-raising have given no results since Marta is seen to produce more overtly visible (and audible) actions by resorting on verbal means. Thus, she finally initiates a news-announcement sequence with hesitant **we we-** while pointing at the microscope for some time (lines 501-502 and 505, Figure 3.1-e). After a 1.0 second pause during which neither the current speaker (the teacher) nor the possible next speaker (Marta) intervenes, the latter attempts again to take the floor: she reports **we see thing** (line 508). Such Marta's 'attention-calling' multimodal actions are reinforced by Sara's hand-raising in line 503 (Figure 3.1-e) and her slight standing up in line 507. Despite being unacknowledged by the teacher, the two girls continue to pursue their goal, that is, to get the teacher's attention, by developing their 'news'. Thus, Marta produces a partly unintelligible and unfinished utterance **xxxx the thi:ng (.) is a-** (line 511) which is completed by Sara's half-reading half-saying **is (sensitive) to the ↓temperature** (lines 512-513).

So, it can be seen how throughout lines 492-513 the two students tightly collaborate in all the phases of their – though parallel to the teacher's – highly academic activity of the observation of a natural phenomenon and the announcement of its results which is thus closely related to their previous group work during the experiment. They timely coordinate their multimodal actions when they silently check their finding, attempt to attract the teacher's attention non-verbally in order to be allowed to announce it and finally directly state their discovery verbally. Mobilizing a wide range of multimodal resources, i.e., language, body movement, gesture, gaze and material artefacts (the microscope and their notes), they jointly and effectively elaborate a complex news-announcement (Figure 4.4-3):

SAR: *gaze -> microscope + hand-raising* MAR: *gaze -> notes + hand-raising*
 gaze -> microscope *gaze -> TEA + hand-raising* we we- *pointing gesture ->
 microscope* SAR: *hand-raising + slight body-raising* MAR: we see thing
 xxxx the thi:ng (.) is a- SAR: is (sensitive) to the ↓temperature

Figure 4.4-3. Students' news-announcement co-constructed in Excerpt 3.1, lines 492-513

It is also worth noting that even though Marta intervenes more than her partner (both verbally and non-verbally) and expresses herself using informal L2 discourse, she still seems to have difficulties in delivering her verbal message (see her repetitions, hesitations, cut-offs and micro-pauses). The following assumption may be put forward: Marta self-selects as a possible next speaker who is to do the announcement and hence tries to reify a personal classroom experience which on other occasions in this session have been commonly conveyed through everyday L1 (see e.g., Excerpt 1.2). However, she finds out that scientific knowledge to be constructed and communicated is too abstract and difficult for one who is still learning how to talk school-science accountably and moreover to do it in the target language. Her deictic gesture at the microscope (line 501) corroborates this assumption since 'because of difficulties with the verbal channel, L2 learners can develop other means for both portraying and comprehending meaning, including relying more on nonverbal than verbal modes' (McCafferty, 2002: 195).

On the contrary, Sara seems to lean heavily on one of the statements in the handout (see Figure 4.4-4 below) from which she borrows terms such as 'sensitive' and 'temperature'. It may be suggested that it is precisely this that has helped her to produce a school-science statement in the L2.

Euglena is sensitive to temperature

Figure 4.4-4. Statement used by Sara in news-announcement (Excerpt 3.1, line 513)

Marta and Sara's actions clearly indicate a misalignment in the two agendas present in the classroom: that of the teacher who pursues her pedagogical objective of guiding the class through the final plenary – of which her reconstructive and more general recap of the students' empirically proved pieces of evidence is an essential part – and that of the two students who want to publicly announce their discovery to the teacher and the rest of the class. As the analysis

has shown, at some point such misalignment resulted in the students' interactional 'struggle for voice' (Britzman, 1989).

Yet, the two girls struggle for voice brings them no immediate result: their attempts of 'telling' are not ratified by the teacher and they are not officially given the floor until she finishes her elaborated recapping of Andrew's statement and nominates Marta in line 514:

Excerpt 3.2

514. **TEA:** ↑Marta
515. **MAR:** ***the thing white that we ↑see::**
516. *arn* **tries to look into MAR and SAR's microscope*
517. ***(2.5)**
518. *arn* **tries to turn the optic tube towards him*
519. *mar* **slightly hits ARN's hand several times*
520. **MAR:** **e:m now it doesn't move.**
521. ***(1.5)**
522. *arn,* ***fig3.2-a***gaze at TEA*
mar,
sar,
car



Figure 3.2-a

The teacher's nomination (line 514) opens Marta and Sara' reporting sequence making it finally official and public: **the thing white that we ↑see:: (2.5) e:m now it doesn't move** (line 515, 517, 520). What Marta produces is actually a highly elaborated statement from the linguistic perspective. First of all, it is done in the target language, the fact that may be explained by the very interactional context of delivering an official reporting. Second, it is structured as a complex utterance 'the thing white now it doesn't move' with an embedded

dependent adjectival clause 'that we see'. To accomplish it, she employs different semiotic resources which clearly reveal her efforts to transform her and Sara's empirical observation into academic discourse in the L2. Thus, she stretches one of the key verbs, namely that of visual perception (**see: :**, line 515), produces a very long pause of 2.5 second (line 517) and ultimately hesitates before articulating the most important part of her statement containing the actual reporting, that is, that the microorganism which she calls 'the white thing' and which her group has examined under the microscope does not move any more (line 520).

From the perspective of the sequential organization of interaction, Marta also shows herself as a situated competent participant because she effectively holds the interactional floor which has been finally given to her by the teacher. She accomplishes it by strongly projecting the continuation of her turn with the embedded adjectival clause, slightly rising intonation and the verb stretching (**that we ↑see: :**, line 515). Thanks to such a clever and highly elaborated interactional move and in spite of the notable 2.5 second pause, she is able to maintain her position of the officially recognized current speaker and ultimately deliver her principal message. With a final falling intonation at the last word (**move**) she explicitly marks the end of her reporting (line 520).

It should also be mentioned that her efforts to construct an utterance in the target language and simultaneously keep hold of the unfolding talk are faced with an additional problem caused by a student sitting next to her, Arnau. More precisely, he seems to intend to check the girls' finding as he attempts to turn the optic tube of their microscope towards him in order to look into it (lines 516 and 518). However, Marta, who is working hard on achieving her two concurrent goals, tries to simultaneously block him by slightly hitting his hand on the tube several times. This eventually leads to her extremely long pause in line 517.

Once Marta has closed her turn, there is another quite long pause of 1.5 second (line 521) during which Marta, Sara, their third partner Carla, and Arnau overtly self-orient to the teacher through their prolonged gazes (line 522, Figure 3.2-a) in the expectance of her evaluation of Marta's reporting. The teacher's demonstration of understanding **↓a: (.) it doesn't move?** comes in line 523:

Excerpt 3.3

523. **TEA:** ↓**a:** (.) **it doesn't move?**
Translation: oh:
524. *mar* *slightly shakes head*
525. **SAR:** **yes (.) the the-**
526. **AND:** **it's dead.**
527. **TEA:** **the transparent thing?**
528. **SAR:** *↓**yes**
529. *mar* **nods*
530. **AND:** **it's dead.**

It has been already observed in interactional projects 1 and 2 that on similar occasions (Excerpt 1.6, line 87 and Excerpt 2.2, line 251) – and here perhaps due to the fact that Marta's reporting is not explicitly related to the examined statements from the handout – the teacher acknowledges her news-receipt with brief ↓**a:**, thereby suggesting the closing of the reporting sequence.

Still, in the same turn the teacher launches a sequence of negotiation of meaning which expands Marta's public reporting. After a micro-pause, the teacher solicits her (or the group's) confirmation by literally repeating the final part of Marta's utterance (**it doesn't move?**, line 523). Her request is prosodically marked as a 'claim of insufficient knowledge' (Sert, 2011) as she emphasizes the key item represented by the verb 'move' and shapes her utterance intonationally as a question. Marta and Sara provide the expected confirmation. The former, non-verbally by slightly shaking her head (line 524) and the latter with a short 'yes' which is followed, after a micro-pause, by an attempt to specify her confirmation but which is finally cut off perhaps due to a too high cognitive and linguistic demand (**yes (.) the the-**, line 525).

It is noteworthy that at this moment another student, Andrew, who belongs to a different pair, joins the on-going interaction. Once having accomplished his public reporting in line 491 (Excerpt 3.1) within the teacher-led class plenary, he re-takes a situated identity (Zimmerman, 1998) of the listener (and potential critiquer) of knowledge claims reported by other nominated students in the form

of examined and verified statements about Euglena. Yet, now he intervenes by emphatically stating that *it's dead* (line 526), thereby positioning himself in his new discourse role of the co-constructor of a claim. It may be inferred that in his verdict he draws on Marta's public reporting that the observed microorganism has stopped to move.

The teacher however seems to seek more precision necessary for the establishment of a shared understanding of the students' discovery since she requests another confirmation in line 527 (*the transparent thing?*). This time Sara and Marta respond simultaneously: the former produces a short 'yes' (line 528) while the latter again confirms non-verbally, this time however sending a positive message with a nod (line 529). Andrew also attempts to contribute to the on-going negotiation of meaning by repeating his previous statement, this time with a neutral intonation (line 530).

It may be an appropriate moment now to comment that in line 527 the teacher articulates a very concrete question (*the transparent thing?*) containing a lexical item 'transparent thing' which apparently has no direct relation to 'white thing' in Marta's reporting. And yet, the teacher immediately receives the students' confirmations.

The search of the key item 'transparent' throughout the data corpus has revealed two earlier occurrences. Both took place earlier the same activity 2.1 when the teacher asked different students' about their findings in order to provide a first recap of what they had seen to the rest of the class. The first one (Excerpt 3.4) occurred 17 minutes 30 seconds before Excerpt 3.3. In it Sara announced in the L1 that *'hi ha una cosa blanca que es MOU'* ('there is a white thing that moves', line 26) while Marta confirmed to Jaume (also in the L1) that this 'white thing' was transparent (line 28). This was followed by a private conversation between Sara, Marta and the teacher. The latter explained to the girls that what they had found seemed to be an example of protozoa (one-celled organisms similar to Euglena) and referred to an image in the reference book. Having looked at the image, Sara emphatically confirmed (this time in the target language) its similarity with their 'white thing'.

Excerpt 3.4

26. SAR ↑*E::I* (.) *hi ha una cosa blanca que es MOU*

Translation: hey (.) there is a white thing that moves

27. JAU: **xxxxxxxx**

28. MAR: ↓*SÍ* (.) *transparent.*

Translation: yes (.) transparent

29. TEA: ↓*yes. because there are other organisms, protozoa,*

30. *other* ↑*organisms* (.) *that swim in* ↑*the::se-*

31. *among the Euglena.*

32. MAR: *it's bigger tha::n-*

33. TEA: *yes. *it's a kind* ↑*of- thing like this.*

34. *tea* **takes reference book and looks through it----*

35. **(3.5)*

36. *tea* **---->*

37. TEA: *it's like *this.*

38. *tea* **points at image*

39. *sar* **gazes at image*

40. SAR: ***YES**

The second emergence of the item 'transparent' (Excerpt 3.5) – also in a private interaction with the teacher – happened 7 minutes 40 seconds before Excerpt 3.3. In it Sara asked the teacher about the exact location of the 'transparent thing' in the reference book. Having started her utterance in the L1, she yet switched to the target language and incorporated the key lexical item in the L2 ('*en aquest llibre ón esta la: transparent thing?*', 'in this book where is the transparent thing?', lines 326-327). Once the teacher offered her tentative categorization of the 'transparent thing' as a 'ciliate' (another type of one-celled microorganisms), Sara solicited the exact page number in the reference book. The teacher started to search for the image of the organism in the book and, once found, showed it to Sara who claimed he understanding with short ↓a:

Excerpt 3.5

326. SAR [TEA's name] (.) en aquest llibre ón esta la:

Translation: [TEA's name] (.) in this book where is the

327. transparent thing?

328. JAU: e:?

329. SAR: la ↓transparent thing

330. TEA: I think it's a ciliate.

331. SAR: in what page?

332. TEA: *I think (.) it must be *this.

333. tea *looks through reference book *points at image

334. SAR: ↓a:

So, the complementary data presented in Excerpts 3.4 and 3.5 may explain why in line 527 (Excerpt 3.3) the teacher directly employs 'transparent thing': she seems to refer to her previous private conversations with Marta and Sara.

Let us now turn to Excerpt 3.6, the last one in interactional project 5. It starts with another student, Arnau, joining the unfolding talk:

Excerpt 3.6

531. ARN: ↓>a<

Translation: oh

532. arn *fig3.6-a* looks into the microscope



*
Figure 3.6-a

533. ARN: >de tant calentar-↑ho [ja es mort.<

Translation: we've been heating it so much it's dead

534. AND: [ours is dead.

535. (2.0)
536. TEA: ↓so (0.5) this this this ↑organism (0.5)
537. is sensitive to temperature.

In line 531 Arnau produces the news-receipt token in the L1 (↓>a<), thereby claiming his sudden understanding of the shared knowledge being jointly built up by other interactants. With this short intervention he self-positions as the co-constructor of the scientific claim in progress. Then he re-orientes his body and gaze at Marta and Sara's microscope in order to examine their sample (line 532, Figure 3.6-a). Through such embodied actions he effectively introduces the artefact into interaction as a significant mediating tool necessary for the on-going process of meaning making.

It seems that he succeeds in achieving his goal, that is, confirming the exactness of the observation reported by Marta and establishing what caused the microorganism's death: its overexposure to heat. This is evidenced in line 533 in which he publicly announces his discovery in the L1: >de tant calentar-↑ho ja es mort.< ('we've been heating it so much it's dead').

Several tentative assumptions may be put forward. First, that his multimodal actions reveal his close attentiveness to unfolding interaction and the actions of other participants which allows for arguing that his previous role of listener in no way implied passivity (Duff, 2002). Second, that both his classmates' and the teacher's sequential contributions organized into a question-answer pattern and framed within a series of teacher-led sequences of the negotiation of meaning have served him as relevant contextualization cues¹³ (Gumperz, 1992). And finally, that their contributions provided scaffolding he needed to become able to arrive at his conclusions and publicly establish a logical relationship of cause-effect using the L1 everyday discourse.

¹³ According to Gumperz (1992: 230), *contextualization* is 'speakers' and listeners' use of verbal and nonverbal signs to relate what is said at any one time and in any one place to knowledge acquired through past experience, in order to retrieve the presuppositions they must rely on to maintain conversational involvement and assess what is intended'.

Let us now track the path that the students' followed in discovering almost 'independently' – yet being carefully guided by the teacher – school-science knowledge behind Marta and Sara's finding and co-constructing a logical chain of claims. This path can be schematically presented as the following (the students' paraphrased claims are given in italics):

(1) MAR + SAR: *'The white [transparent] thing' they have found doesn't move any more.*

-> (2) AND: Why did it stop to move? -> *Because now it's dead.*

-> (3) ARN: Why is it dead? -> *Because it has been heated too much time.*

Overlapping with the second part of Arnau's contribution (line 533), in line 534 Andrew uses L2 everyday register to announce that his group's microorganism has also died from the prolonged heating (**ours is dead**). Finally, a 2.0 second pause in line 535 seems to bring to its end a series of sequences of the negotiation of meaning through which the students and the teacher have jointly reached a shared understanding of the students' finding and co-constructed a dialogic explanation of its cause.

In lines 536-537 the teacher uses a discourse marker 'so' and features it prosodically (strong emphasis, falling pitch) as well as separates it from the subsequent part of the utterance by a 0.5 second micro-pause, thus indicating the end of the previous prolonged sequence. At the same time it seems that the teacher employs the marker as a means to relate what she is going to say to the preceding talk as its logical inference. This is precisely the case as in her next utterance – **this this this ↑organism (0.5) is sensitive to temperature** – she gathers the students' contributions made in both L1 and L2 everyday discourse and offers to the whole class an official conclusion of the preceding joint discussion.

More particularly, the teacher first substitutes a colloquial word 'thing' employed by Marta (line 515) and herself (line 527) with a reification, 'organism', and then, drawing on Arnau's reasoning that 'we've been heating it so much it's dead' (line 533), paraphrases Marta's 'it doesn't move' (line 520) and Andrew's 'it's is dead' (lines 526 and 530) and 'ours is dead' (line 534) into an accountable L2

statement 'this organism is sensitive to temperature'. These interactional adjustments allow her to recap and officialize their common endeavour towards generating a shared understanding of the phenomenon initially observed by Marta and Sara. They also help her transform their new, interactionally constructed and now common knowledge into a more general and rigorous statement in the appropriate L2 school-science discourse.

4.4.2. Summary and discussion

A detailed examination of the four Extracts that make up interactional project 3 has shown that the participants accomplished the following route in developing a shared understanding and co-constructing a dialogic explanation:

1. The teacher nominates one of the students (Andrew) to do an official reporting.
2. Having requested clarification and been repeatedly offered the interactional floor, Andrew does the reporting in the L2.
3. The teacher acknowledges his contribution and constructs a complex recap on the student's reporting.
4. In parallel to the teacher, two students (Marta and Sara) initiate a series of 'attention-calling' actions in order to take the interactional floor for which they employ diverse multimodal meaning-making resources. Finally, they announce their discovery.
5. The teacher does not ratify the students' parallel actions until she ends her extended recap.
6. The teacher nominates Marta thereby publicly giving her the floor and opening a new reporting sequence.
7. Marta produces a linguistically complex and interactionally competent contribution in the target language.

8. The teacher accepts the student's reporting and initiates a sequence of the negotiation of meaning by soliciting a series of confirmations of what has been reported.
9. Marta and Sara provide the requested confirmations while Andrew joins the unfolding talk and offers another claim, thereby moving the co-construction of the explanation of Marta and Sara's finding forward.
10. Arnau joins the discussion and claims his sudden understanding of the phenomenon. He checks his assumption under the microscope and, once confirmed, publicly announces what has been the cause of the phenomenon under discussion.
11. Andrew announces that the same has happened to his group's sample.
12. The teacher provides a reformulated and official conclusion of the preceding joint discussion.

This route shows that despite the fact that interactional project 3 was initiated by Andrew's nomination to contribute to the on-going whole-class reporting activity, it was the student-driven parallel news-announcement – finally publicly recognized by the teacher and transformed into Marta's reporting – which triggered the joint elaboration of a dialogic explanation. The whole teacher-student co-constructed piece of school-science knowledge can be found below (Figure 4.4-5):

TEA: ↑Marta MAR: the thing white that we ↑see:: (2.5) e:m now it doesn't move. (1.5) ARN, MAR, SAR, CAR: *gaze -> TEA* TEA: ↓a: (.) it doesn't move? MAR: *headshake* SAR: yes (.) the the- AND: it's dead. TEA: the transparent thing? SAR: yes MAR: *nod* AND: it's dead. ARN: ↓>a< *gaze -> artefact* >de tant calentar-↑ho ja es mort.< AND: ours is dead. TEA: ↓so (0.5) this this this ↑organism (0.5) is sensitive to temperature.

Figure 4.4-5. Dialogic explanation co-constructed in Excerpts 3.2, 3.3 and 3.6, lines 514-537

The fine-grained analysis has also revealed that the students deployed a wide range of multimodal resources to accomplish different school-science

activities appropriate of their CLIL classroom CoP. They used languages available to them, that is, the L1 and the L2, as well as other semiotic resources such as gestures, gazes and particularly the microscope, a relevant lab artefact. The students mobilized such meaning making resources to carry out empirical observations of the studied microorganism, report their findings, check their assumptions against different sources of academic knowledge, state explicit knowledge claims or establish relevant logical relationships (e.g., cause-effect).

The students also used multimodal means to accomplish interactional actions such as getting the teacher's attention or maintaining their position as current speakers. In this respect, one semiotic resource deserves a special attention: the target language. Thus, recent studies on L2 learning (e.g., Pekarek Doehler, 2010, in press) argue that language learners may use L2 grammar for holding floor in interaction. They show that learners employ certain grammar constructions such as, for example, left-dislocations as 'time-buying' devices which allow them to search for appropriate wording without being interrupted or repaired by other interactants. Such use of the target grammar structure has been observed in Marta's skilful reporting utterance 'the thing white that we see it doesn't move'.

In respect to the teacher and on the contrary to what has been found in interactional projects 1 and 2, in this interactional project the teacher mainly drew on the L2 verbal and paralinguistic resources in providing scaffolding to the students in their learning to become school-science practitioners. Hence, during the co-construction of the dialogic explanation, she used a series of 'guiding' questions. Meanwhile, in her concluding intervention she transformed the students' everyday wordings of their (the students' and the teacher's) interactionally co-constructed shared understanding of Marta and Sara's finding and its cause into accountable school-science statement in the L2. The fact of the teacher's greater reliance on verbal means may be explained by the very format of the final plenary activity. Being more formal than the preceding teacher-student private conversations during interactional projects 1 and 2, it allowed the teacher to recap and officialize her and the students' common endeavour towards formulating appropriate scientific statements about the observed phenomena in

the L2 but also their more global joint enterprise of teaching-and-learning to talk science in that language as members of their science classroom CoP.

4.5. CHAPTER SYNTHESIS AND GENERAL DISCUSSION

The analyses of the three interactional projects presented in this chapter have provided several important insights into the process of joint construction, negotiation and development of contextually appropriate shared understandings in this CLIL science classroom. The process through which the interactants, that is, the teacher and the students, jointly elaborated school-science dialogic explanations of the observed characteristics of the microorganism *Euglena*, thereby co-constructing new relevant academic knowledge about such phenomena.

In the first place, the analyses have revealed the same interactional pattern in all three interactional projects, that is, that the sequence of the negotiation of meaning that led to the joint construction of the dialogic explanation was initiated by the teacher but was triggered by the students' public questions or reports on their empirical findings. It may therefore be argued that such dialogic explanations were teacher-led but student-initiated.

The fine-grained examination of the sequential organization of interaction in each Excerpt has shed light on the way the participants used resources available to them in order to interactively mediate the co-construction of dialogic explanations. Figure 4.4-6 below shows meaning making resources employed by the teacher and Figure 4.4-7 contains those devices which were mobilized by the students.

TEACHER														
Resource / Action	L1: everyday	L2: everyday	L2: academic	Code-switching	L2: morpho-syntax	L2: deictics	'Oh' token	Prosody	Pause	Gaze	Gesture	Head movement	Body movement	Material artefact
Acknowledge S' contributions	T									T				
Repair S' contributions			T		T									
Assess S' contributions		T												
Legitimate / officialise S' contributions		T (rep)	T (ref)					T			T			
Provide recaps		T	T		T									
Make abstractions			T											
Make generalizations			T (ref)											
Establish logical relations			T		T			T						
Construct comparisons			T		T	T		T		T	T			T
Construct descriptions					T									
Strengthen message			T (rep)					T	T		T			T
Model academic discourse in L2		T	T (r)		T									
Key: T – teacher; S – students; (q) – question; (r) – repair; (rep) – repetition; (ref) – reformulation														

Figure 4.4-6. Multimodal resources and components of classroom interactional competence employed by the teacher to mediate the co-construction of dialogic explanations in interactional projects 1-3

STUDENTS																
Resource \ Action	L1: everyday	L1: academic	L2: everyday	L2: academic	Code-switching	L2: morpho-syntax	L2: deictics	'Oh' token	Creative use of L2	Prosody	Pause	Gaze	Gesture	Head movement	Body movement	Material artefact
State questions, problems			S						S							
State knowledge claims	S	S	S	S	S		S						S			
Check claims																S
Report findings	S		S			S	S			S	S		S			S
Triangulate different sources	S	S			S		S									
Introduce artefact into interaction							S					S	S		S	
Key: T – teacher; S – students; (q) – question; (r) – repair; (rep) – repetition; (ref) – reformulation																

Figure 4.4-7. Multimodal resources employed by the students to mediate the co-construction of dialogic explanations in interactional projects 1-3

Findings presented schematically in Figure 4.4-6 above reveal that the teacher skilfully mediated between the students' empirical classroom experiences and school-science knowledge to create a series of context-dependent situated practices within the particular context of the observed classroom activity, that is, the lab experiment. The meaning making resources and interactional strategies and adjustments deployed by the teacher shed light on her *classroom interactional competence*.

More particularly, she employed an array of mediating multimodal resources in order to afford the students access to relevant academic knowledge. Together, the teacher and the students then used this knowledge to negotiate meanings related to the students' observations and empirical findings (e.g., microorganism's shape changing, its sudden immobility or the presence of a flagellum). Her *learner-convergent* use of the L1 and the target language in both their everyday and academic registers as well as of a range of prosodic elements (e.g., intonation, emphasis, sound stretching), pauses, gazes, gestures and material artefacts contributed to their joint process of creating shared understandings of the observed natural phenomena.

The analyses have also shed light on the way the teacher used different multimodal scaffolding procedures to guide the students in grasping a practice of their science classroom CoP. Namely, she guided the students in their *joint discovery of the scientific procedure of constructing explanations* of what they had seen under the microscope and in *the students' learning of such school-science skill*. With this aim and mainly employing deictics and pointing gestures to contextualize and reinforce her verbal message, she gradually related her and the students' new, interactionally co-constructed shared understandings to relevant school-science knowledge contained in recognized sources of knowledge such as, for example, the reference book.

The teacher has also been found to use linguistic resources (e.g. deictics) as well as prosody and her movements around the laboratory to attract the students' attention or request (sometimes even require) their co-participation. This allowed her to create *a favourable interactional space* and promote the co-participative

process of teaching-and-learning (Figure 4.4-6, see also Figure 4.4-7 for students' contributions). Hence, the students were given opportunities to contribute to classroom interaction and to receive feedback on their contributions both in relation to subject-specific knowledge being co-constructed and the target language used to do it.

Finally, the teacher also used a range of linguistic and non-verbal devices to *shape the students' contributions* to interaction. She repaired their utterances into appropriate L2 academic morpho-syntactic constructions and provided assessment on their interventions. She also legitimated and officialised the students' knowledge claims verbally through repetitions or reformulations of their everyday wordings into knowledge-based, school-science statements in the academic L2, which were usually preceded by a discourse marker 'so', as well as through gazes and gestures.

She also used multimodality to introduce the students into other relevant discursive practices in school-science learning. Thus, through her use of the school-science register of the target language and prosodic devices at the appropriate moments, she established logical relationships and made abstractions and generalizations. Meanwhile, by using deictics, prosody, gaze, gesture and a material object she effectively constructed multimodal comparisons and descriptions. In this way, the teacher modelled how to talk science accountably and, due to CLIL specificity of this classroom, how to do it in the target language.

Let us now turn to the students in the observed CLIL classroom. The analytical findings presented in Figure 4.4-7 above show that interactional space afforded by the teacher allowed the students to take an active role and participate in classroom interaction. To accomplish their situated actions, they skilfully mobilized a wide range of resources. It has been traced that they used linguistic, paralinguistic, verbal and material mediating tools in achieving their objectives.

More particularly, they used their gazes and gestures to multimodally claim or demonstrate their understanding of the talk and actions of other participants, they also efficiently incorporated relevant material artefacts such as a microscope or a biology reference book to display their knowledge or report their findings.

They also efficiently used plurilingual resources such as code-switching and creatively generated target-like lexical items when stating knowledge claims or asking questions related to their observations (see also Moschkovich, 2002). Through such use of meaning making resources available to them, the students actively contributed to the co-construction of dialogic explanations of the observed natural phenomena.

A close analysis of interactional projects 1-3 has also shown a progressively increasing students' participation in the development of dialogic explanations. Thus, in interactional project 1 the students have been tightly led by the teacher through the explanation and they mainly contributed to it by demonstrating their understanding of the teacher's comparison of the two Euglenas (i.e., Jaume's circling gesture, identical and simultaneous to that of the teacher).

In interactional project 2 the students also demonstrated their understanding of the teacher's verbal and non-verbal message aimed at explaining the organism's movement thanks to its flagellum (i.e., Jaume's waving gesture, simultaneous to, yet different from, the teacher's gesture). Yet, they also provided new pieces of evidence for the elaboration of the dialogic explanation as well as introduced relevant artefacts into it (i.e., Quim's suggestion of the type of organisms with a flagellum and his pointing to the image in the reference book, respectively).

Meanwhile, interactional project 3 shed light on the way how the students – being guided by the teacher's questions to the official reporters of the finding – arrived at the cause of the organism's immobility by themselves and collectively constructed the dialogic explanation by establishing a logical chain of appropriate school-science claims.

These findings may tentatively be interpreted as an indication of the students' *progressive learning of how to use material and semiotic tools* (mainly the L2 academic discourse) in accomplishing appropriate social practices within their classroom CoP, one of which is the construction of academic explanations of observed natural phenomena. Through joint participation in socially situated interactions with knowledgeable others, these being both the teacher and the

peers, the students gradually went beyond what they were able to achieve independently at that moment. Hence, it may be suggested that the very act of taking part in classroom interaction helped them move within their *ZPD*: together with their peers and the teacher the students jointly contributed to the on-going activity in which new meanings and knowledge were generated and in this way progress in their learning of a new school-science skill of constructing explanations. Yet, further research on the topic is necessary which would assert or refute this tentative interpretation before any stronger assumption may be put forward.

So, the analyses have furthered our understanding of the way the teacher and the students employed a whole toolkit of multimodal resources in order to accomplish their situated actions in the observed CLIL science classroom. They used them as *meaningful and powerful mediating tools* in the joint activity of talking school-science in the target language, that is, in negotiating meanings, constructing shared understandings and dialogic explanations. To accomplish these relevant social practices within their CLIL classroom CoP, they integrated into unfolding interaction and tightly interconnected languages, prosody, pauses, head and body movements, gestures, gazes and material artefacts present in the classroom.

The participants also used this shared repertoire of linguistic and other meaning-making resources to *interactionally establish a mutual focus* within their on-going activities, thereby displaying their mutual engagement. The synchronization of their multimodal actions provides further evidence in favour of such observation. The establishment of mutual focus between the teacher and the students in the process of co-constructing dialogic explanations indicate that they had common pedagogical goals and shared understandings of desired results in terms of school-science teaching-and-learning (Tobin, 2006). This in turn, allowed them to successfully co-participate in classroom interaction creating thus a 'shared social, physical, symbolic, and mental space' (McCafferty, 2002: 196-197) within their CLIL science classroom.

The fact that in each interactional project the sequences of the negotiation of meaning preceded the construction of a dialogic explanation allows for a tentative suggestion that they were necessary for the establishment of a *joint enterprise* to be pursued through the explanation and therefore rendered essential for the situated teaching-and-learning of school-science in this CLIL classroom CoP. It may be argued hence that the teacher and her students were engaged in the process of teaching-and-learning which they understood as *enculturation* into *becoming school-science practitioners*.

In this process, the students' empirical observations in the laboratory and the use of both everyday language and subject-specific reifications along with other semiotic and material resources were of primary importance in order for them to grasp the practice of school-science within their CoP. Interactively organizing their participation, the teacher and the students assumed different discourse roles and situated identities (e.g., announcers, reporters, observers, experts, co-constructors of scientific claims) by *recognizing* and *participating* in actions relevant to this practice. Finally, in negotiating relevant meanings and developing dialogic explanations, the participants showed their understanding and effective management of the shared repertoire of resources available to them.

CHAPTER 5

STUDY 2: '*WHAT DOES HARMFUL MEAN?*'

COOPERATIVELY TACKLING OPACITY AND DENSITY IN THE PROCESS OF CO-CONSTRUCTING DIALOGIC EXPLANATIONS IN THE CLIL SCIENCE CLASSROOM

5.1. CHAPTER OVERVIEW

This chapter will present a close examination of interactional project 4 entitled *What does 'harmful' mean?* which focuses on the data collected in session 2 (see section 3.4.3.2). The analysis is lead by the following research question:

What interactional resources do the participants employ to signal and tackle cooperatively linguistic and conceptual obstacles, which emerge in the process of elaborating dialogic explanations and which are caused by L2 opacity and subject-matter content density?

It uses the constructs *opacity* and *density* in order to explore and characterize the process through which the teacher and the students signal and jointly tackle linguistic opacity and content density in the observed CLIL science classroom.

Additionally, interactional scaffolding provided by the teacher in the process of constructing dialogic explanations will be explored in detail in order to identify and portray the components of her classroom interactional competence.

5.2. INTERACTIVE PROJECT 4: *WHAT DOES 'HARMFUL' MEAN?*

Session 2 was dedicated to different types of cells and covered the following teacher-led whole-class activities and subject-matter content:

1. Checking homework (dossier):
 - 1.1. Students presented the results of their Internet-based search of information about main features of bacteria cells.
 - 1.2. The teacher and students checked a true-false activity which aimed to compare information presented in activity 1.1 with previously covered content on amoebas, animal cells and plant cells.
2. Two central activities on new content (dossier):
 - 2.1. Students made estimations of the size and shapes of animal cells,
 - 2.2. They matched words and definitions of different specialized cells (e.g., red blood cell, neuron, muscle cell).
3. Negotiation of quality criteria for the students' oral presentations on endangered animals.
 - 3.1. The teacher and the students jointly generated a list of elements and criteria which the students' oral presentations would contain and which the teacher would use to assess the presentations.

Interactive project 4 corresponds to a teacher-led discussion generated while checking the answers provided by the students to a true-false activity 1.2 (see Figure 5.2-1 below for a small-scale size; see also Appendix 4 for the original size).

- True or false:**
- Amoebas have a nucleus and a cytoplasm.
 - Bacteria have a cell membrane and a nucleus.
 - Bacteria have a cell wall.
 - Bacteria have mitochondria.
 - Amoebas and bacteria are one-celled organisms.
 - Plant cells have a cell wall.
 - Animal cells have chloroplasts.
 - Plant cells do not have mitochondria.
 - Bacteria cells are simpler than animal and plant cells.
 - Animal and plants are many-celled organisms.
 - All bacteria are harmful.

Figure 5.2-1. The list of statements in the dossier

5.2.1. Analysis

The participants in this interactional project are the teacher (TEA) and the following students: Andrew (AND), Carla (CAR), Gerard (GER), Jaume (JAU), Joan (JOA), Marta (MAR), Miquel (MIQ), Ricard (RIC), Sara (SAR) and Vanesa (VAN). Figure 5.2-2 presents the spatial distribution of the majority of the participants in Laboratory 1¹.



Figure 5.2-2. Spatial distribution of the participants in interactional project 4
(Figure corresponds to Excerpt 4.1, line 6)

¹ Gerard, Miquel and Sara cannot be seen in Figure 5.2-2 due to the position of the camera.

The interactional project takes place 10 minutes into the lesson. It has been divided into six shorter Excerpts which show that Andrew, being nominated by the teacher, reads aloud the last statement from the dossier ('All bacteria are harmful', see Figure 5.2-1 above) and states that it is false. The teacher accepts his contribution and asks the class about the meaning of the word 'harmful'. Having received several tentative answers from the students, the teacher provides the word's translation and its antonym (Excerpt 4.1). Then the teacher initiates a whole-class recap. In parallel, Ricard and Jaume become engaged in a private conversation about the meaning of 'harmful' and finally publicly ask the teacher (Excerpt 4.2). Their questions trigger a prolonged teacher's explanation and the students contribute to its interactional co-construction (Excerpts 4.3-4.5). Once the dialogic explanation has been accomplished, Ricard again requests about the word 'harmful' to which the teacher again provides the translation (Excerpt 4.6).

Excerpt 4.1 starts when one of the students, Andrew, raises his hand to bid for a turn as he wants to attempt the next statement (line 1).

Excerpt 4.1

1 *and* *raises hand*
2 **(0.5)**
3 *tea* **looks at AND----*
4 TEA: ***you?***
5 *tea* **points at AND with forefinger*
6 AND: ***all bacteria *are harmful.* *false.**
7 *and* **reads* ** *looks at TEA*
8 *tea* *-----> *turns away from AND, looks into dossier*
9 **(0.6)**
10 TEA: ***false.**
11 *tea* **looks at AND*
12 TEA: ***do you know the word harmful?**
13 *tea* **looks over class*
14 JAU: **[e:: malas?**

Translation: e:: bad?

15 VAN: [°xxxx°

16 tea looks at VAN----

17 TEA: **perjudici*↓al**

Translation: harmful

18 tea ----->*looks at JAU

19 TEA: ***e? the opposite is beneficial.**

20 tea *looks at AND

After a short pause (line 2), the teacher looks at the student, and then nominates him explicitly using a verbal (**you?**, line 4) and a gestural ‘pointing’ (line 5). Being officially nominated, Andrew reads out the statement and then announces his verdict – ‘false’ – while orienting his gaze to the teacher which can be interpreted as a request for her confirmation (lines 6-7). Meanwhile, the teacher continues gazing at him for a while and then looks into the dossier perhaps in order to check the statement (line 8). After another short pause in line 9, the teacher confirms Andrew’s verdict multimodally as she repeats it with an emphasis while looking at him again (lines 10-11). Then she addresses the whole class with a ‘yes/no’ interrogative: **do you know the word harmful?** (line 12). In such a way she de-contextualizes the lexical item from the statement it was used in (see Figure 5.2-3 below). By explicitly problematizing it she opens a language-related episode or remediation sequence in which students are required to display knowing by demonstrating ‘having known’ prior to being asked (Koole, 2010).

- All bacteria are harmful.

Figure 5.2-3. The statement from the dossier that triggers interactional project 4

Several students offer their contributions: in line 14 Jaume, hesitating and with a rising intonation, provides a tentative translation (Spanish ‘*malas*’ means ‘bad’) while Vanesa’s utterance in line 15 is unintelligible. Even though Jaume’s demonstration of knowledge could be considered acceptable both from the point of view of the meaning (the two words are near synonyms) and of the grammar (the adjective ‘*malas*’ is in agreement in number and gender with the Spanish

noun, '*bacterias*'), the teacher does not acknowledge it. Looking consecutively at Vanesa, Jaume and Andrew (lines 16, 18 and 20), she provides the class with a more accurate translation *perjudicial* (line 17) that belongs to L1 educated discourse. This is followed by a comprehension check (e?) and an explicitly stated antonym (*beneficial*) (line 19), a new term in L2 which will be used later. With this the remediation sequence initiated by the teacher in line 12 is closed and there is no demonstration of (non-)understanding from the students that would indicate whether the sequence has led to the successful comprehension of the item in question or not.

The two key decisions made by the teacher in this Excerpt deserve special attention. In the first place, the reason why she problematizes the term 'harmful' and thus opens a remediation sequence when, apparently, there is no evidence in the lesson that the class is running into any snag. The second one is the reason why the teacher does not accept Jaume's candidate translation which seems to convey the intended meaning and chooses to feed a more accurate translation into the students. If the first decision had taken place in isolation it could have been inferred that she was trying to prevent a possible obstacle to understanding due to the potential opacity of the L2 concept, which is a plausible interpretation. However, the teacher's exact translation, together with the presentation of the antonym 'beneficial' (which happens to be a cognate in Spanish) allows for a suggestion that she is not only concerned about the students achieving an accurate understanding of the concepts under discussion through their un-densification. She is also setting demands on the use of language which is precise and accountable to the academic domain where the presence of colloquial language seems not to be acceptable in the light of the decisions taken by the teacher.

17 seconds later, the teacher's recount of statements in the dossier aloud (Excerpt 4.2, lines 40-43) indicates a move to the next stage of the activity, namely, that the statements' checking is over and now it is time for a recap. Since the aim of the activity has been to find out which statements are true and which are false, their public counting seems to be a procedure to help students check over their answers.

Excerpt 4.2

40 TEA: **there are (.) *one, two, three, four, five, six,**
41 *tea* **counts sentences in dossier----*
42 TEA: **seven, eight, nine, ten, eleven.**
43 *tea* ----->
44 RIC: ***°que vol dir *harm*fu:l°?**
Translation: what does harmful mean?
45 *ric* **turns to JAU*
46 *jau* **looks at RIC*
47 *ric* **looks at JAU----*
48 TEA: **how many are good?***
49 *tea* **looks over class*
50 *jau* *looks at his notes in dossier*
51 JAU: ***xxxxxxxx [xxxxxxxx]**
52 *jau* **looks at RIC*
53 *ric* ----->
54 AND: **[ten**
55 GER: **[eleven**
56 RIC: **[*(a:)**
Translation: (oh)
57 *ric* **looks at his notes in dossier*
58 SAR: **(diez)**
Translation: (ten)
59 *ric* *looks at JAU*
60 TEA: ***ALL?**
61 *tea* **shakes head quickly*
62 *jau* *looks at TEA**
63 JAU: ***harm[↑ful-**
64 MAR: **[ten**
65 *ric* *turns to TEA**

66 RIC: *what [(is) °harm]ful °?=
67 AND: [=nine]

In lines 48-49 the teacher tries to involve the class in the recap process both with a verbal solicit (**how many are good?**) and a sweeping gaze. Yet, the replies she obtains from Andrew, Gerard and Sara (lines 54, 55 and 58) do not match her expectations, the fact she explicitly expresses in lines 60-61. However, the new responses (Marta in line 64 and Andrew in line 67) are still confusing.

Interwoven with this whole-class negotiation sequence, a situation similar to that analysed in chapter 4 (Excerpt 3.1) can be observed: two students show signs of carrying out a parallel activity throughout lines 44 to 59. In line 44 one of them, Ricard, starts a private conversation with a classmate next to him, Jaume. He addresses him in L1 and physically orients himself towards him (see change in body posture and gaze direction in lines 45 and 47). By asking his peer *que vol dir harmful:1?*, he initiates a remediation sequence in which the lexical item already explicitly problematized and explained by the teacher through translation (Dalton-Puffer, 2011) in Excerpt 4.1 is again de-contextualized.

Jaume acknowledges Ricard's request by looking at him (line 46) and attends to its content by checking what he has written in his dossier (line 50). While looking again at Ricard, Jaume says something that results unintelligible for the analyst but seems quite comprehensible to his peer (lines 51-53) who reacts to Jaume's contribution with a series of multimodal actions. Thus, Ricard produces a change-of-state token *a:* with a neutral intonation, he checks his own notes and finally gazes again at Jaume (lines 56-57 and 59). Such series of actions lets us suggest that the problematic term remains opaque. The multimodal resources employed by both students clearly show how they progressively establish mutual orientation both to each other and the problematic concept through the sequential changes in their gazes and body position: Ricard, by turning to and looking at Jaume, then at his notes and then again at Jaume in lines 45, 47, 53, 57 and 59, and Jaume, by looking first at his peer, then at his notes and then again at Ricard in lines 46, 50 and 52.

At this moment it seems that both students have used up the resources available to them in their private interaction without having solved the problem and decided to solicit the teacher's help. This is evidenced by the fact that Jaume reorients his gaze from Ricard to the teacher (line 62) and then publicly states the problem by pronouncing the term with a rising intonation (line 63). He is followed by Ricard who changes both his gaze and body orientation towards the teacher (line 65) in an effort to catch her attention thus showing that Jaume and he continue carrying out a joint enterprise. He goes even further as he produces a longer utterance **what (is) °harmful°?** to display his lack of understanding of the explicitly de-contextualized obscure term.

Excerpts 4.3-4.5, presented and analysed below in a consecutive way, belong to the same prolonged episode of the teacher's explanation. To facilitate the reading and comprehension of the analysis, they are presented separately.

Excerpt 4.3 shows that Jaume and Ricard's public clarification request on the meaning of the problematic term 'harmful' stated in Excerpt 4.2 (lines 63 and 66) triggers an elaborated explanation on the part of the teacher.

Excerpt 4.3

68 TEA: ***<harmful means that produce (0.3) harm (.)**
 69 tea **looks at JAU, over class*
 70 TEA: **something bad for ↓us>**
 71 TEA: **for example (.) ↓illnesses *(1.0)**
 72 jau **writes down----*
 73 TEA: **↓infections *(0.6)**
 74 tea **leans forth*
 75 mar **writes down----*

Addressing the class, the teacher starts her explanation with an etymological definition of the concept (**harmful means that produce harm**)² (line

² Compare the teacher's definition to the one given in the Oxford Dictionaries Online (2011): 'harmful - causing or likely to cause harm'.

68), followed by a micro-pause, and one second definition in colloquial language (**something bad for us**) (line 70). Several features in this initial part of the explanation are worth noticing:

- a) The problematic term is being contextualized through a mediation sequence;
- b) Both the etymological and the colloquial definitions are offered in the target language;
- c) The speech rate is noticeably slower than the surrounding talk which highlights the importance of the information being provided and favours its understanding by the students;
- d) The reformulation in everyday language actually incorporates a translated version ('bad') of Jaume's earlier contribution in the L1 (Excerpt 4.1, line 14), and
- e) The teacher employs a personal pronoun 'us' which may indicate her attempt to construct her explanation as a shared experience (compare her use of 'you' in Excerpt 4.1, line 12).

Once the definition is provided, the teacher proceeds with the explanation and the mediation sequence: with the words **for example** she introduces two illustrating examples (lines 71 and 73): 'illnesses' and 'infections'. The former is a more general and superordinate term and is represented by a more linguistically distant L2 item (compare English 'illness' to Spanish '*enfermedad*' / Catalan '*malaltia*'). Meanwhile, the latter is not only a more accurate term that exemplifies a type of illness but is also very similar to the students' L1 (compare English 'infection' to Spanish '*infección*' / Catalan '*infecció*'). It should also be noted that 'illness' is a commonly used everyday word in English, while 'infection' is a specific reification proper of school-science register. By introducing these two examples, one being thus a relatively general and colloquial but unfamiliar L2 item and the other though being a much more specific and concrete content term but cognate in the L1, the teacher constructs a complex semantic network among the scientific

reifications 'illness', 'infection', 'beneficial' and 'harmful' in which each supports the others and helps to shed light on and uncover the meaning of the other terms.

The relevance of these examples for the explanation that is being developed can also be observed in multimodal resources employed by the teacher, that is, emphasizing and framing each term between long pauses and her physical leaning forth towards the students. The effect of her current, much more contextualized, explanation can be seen in that Jaume (line 72), Marta (line 75) and Carla (Excerpt 4.4, line 81) start jotting down some notes in their dossiers which gives way to an assumption that this part of the explanation has been successfully understood by the students³. It should be moreover kept in mind that nothing of this type occurred in Excerpt 4.1.

In next Excerpt the teacher continues elaborating her explanation.

Excerpt 4.4

76 TEA: **but (0.5) we don't *e::**
 77 tea **leans back*
 78 TEA: ***we haven't to think *that all *bacteria**
 79 tea **looks at VAN* **looks at dossier*
 80 tea **leans forth*
 81 car **writes down----->*
 82 mar *----->*
 83 jau *-----*
 84 TEA: **are ↓harmful (0.2)**
 85 jau *----->*
 86 TEA: ***not all bacteria *cause ↓illnesses (.)**
 87 tea **looks at JAU, over class*
 88 tea **shakes head*
 89 jau *turns to JOA**
 90 JAU: ***xxxxxxxx a(h)re harm(h)ful**

³ See Koole (2010) on students' non-verbal demonstrations of understanding.

91 TEA: **there are some that are (0.5)**

92 TEA: ***beneficial| for| us|,**

93 tea **nods at each word*

94 tea **slightly points at herself*

In line 76, by using an emphatically stressed negative conjunction **but** the teacher explicitly marks that the explanation is not finished and that what is going to be said is important content knowledge. After a short pause, she starts a negation, hesitates, which is evidenced in the stretching of the interjection **e: :**, and finally produces a reformulated and complete negation **we haven't to think that all bacteria are harmful** (lines 78 and 84). On the one hand, this negation contains a 'we'-statement which strengthens the teacher's orientation to a shared enterprise with the students. On the other, it is the teacher's reframing of Andrew's positive statement in Excerpt 4.1 (**all bacteria are harmful**, line 6) which she literally embeds into a negative construction with the emphasis on the word 'all'. She thereby re-contextualizes initially affirmative statement in order to develop her explanation.

From line 86 on, the teacher reformulates her previous utterance (Statement 1) twice with a series of discursive moves and adjustments that are schematically summarized in Figure 5.2-4:

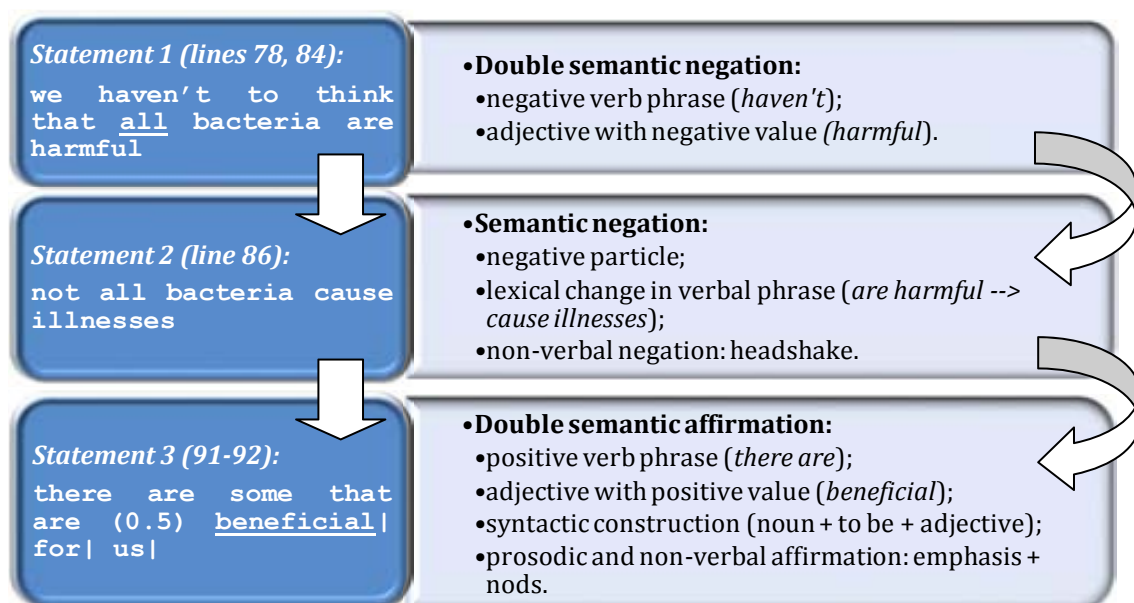


Figure 5.2-4. Teacher's discursive strategies and adjustments used in the elaboration of the explanation

So, in line 86 the teacher first places a negative particle **not** before the same subject 'all bacteria' and then changes the verbal phrase from **are harmful** to **cause illnesses**. Whereas 'are harmful' contains the opaque lexical item that has been publicly problematized by both the teacher and the students, 'cause illnesses' retrieves one of the four concepts, namely 'illness', from the semantic network that the teacher has constructed earlier. In doing so she makes use of a rich variety of remediation strategies within the unfolding mediation sequence, with both processes (remediation and mediation) intertwined in her explanation and equally aimed at solving the problem of understanding of an unfamiliar (and thus dense) concept 'harmful' in the opaque L2. This new – negative – verbalization (and conceptualization) of Andrew's statement is additionally strengthened by her body language as 'cause illnesses' is accompanied by a headshake (line 88).

The teacher continues constructing her explanation but now she changes the remediation strategy from the negation to affirmation (lines 91-92). She reformulates a negative noun phrase **not all bacteria** into a positive one, **there are some that**, and replaces the predicate **cause** from line 86 which contained negative connotation to an affirmative verbal phrase **are beneficial** in line 92. Thus, she both returns to the initial syntactic construction ('to be + adjective') and retrieves the antonym to 'harmful' that she has officially introduced in Excerpt 4.1 (line 19). As it happened in line 88 when the teacher used the additional non-verbal negation, here she again employs multimodality to support her verbal message: apart from the key term 'beneficial' being highlighted emphatically, the words conveying positive information are rhythmically marked by a series of confirming nods (lines 92-93).

In this Excerpt it has been observed how the teacher recycles the initial statement 'all bacteria are harmful' containing the problematic item as a trigger for her explanation. She skilfully develops the explanation by making a series of morpho-syntactic and lexical changes to the original statement, on the one hand, and by employing three of the four concepts ('harmful', 'illness' and 'beneficial') which she introduced earlier, thereby gradually strengthening semantic relations among them, on the other. Moreover, the path she traces for the students ('all bacteria are harmful' -> 'not all bacteria are harmful' -> 'not all bacteria cause

illnesses' -> 'some bacteria are beneficial') can be considered a more elaborated, contextualized and comprehensible version of what can be found in Britannica Concise Encyclopaedia for Kids online (2011): 'although some bacteria are harmful, many bacterial species are beneficial'.

Excerpt 4.5 starts with the teacher announcing that she is going to illustrate the line of argument she has developed up to that moment.

Excerpt 4.5

95 TEA: **for** ↑**example**=

96 AND: **=xxxx**

97 TEA: ***we can use them**

98 tea **looks at AND*

99 TEA: ***<to make some *food>**,

100 tea **looks at JAU*

101 tea **counts with fingers----*

102 ric **raises hand----*

103 TEA: ***do you know Actime::l, e: el-* this yoghurt,**

104 tea **looks over class*

105 tea ----->*

106 ric ----->*

107 TEA: ***that e:**

108 ric **raises hand----*

109 TEA: ***lactobacillu::s ↑tal or::: casei ↓immunitas:**

110 tea **writes in air with hand*

111 ric -----

112 TEA: ***all of these ↑are:**

113 tea **looks at RIC, nods----*

114 ric ----->

115 RIC: **BACTERIA**

116 tea ----->

117 *jau* *turns to JOA**

118 JAU: ***°ca(h)sei immu(h)nitas°**

119 TEA: ***and they are good for us (.)**

120 *tea* **looks over class*

121 TEA: **for our digestive *system for example.**

122 *tea* **points at stomach*

In line 95, the teacher thus moves again from more general to more concrete within the mediation sequence. Though she verbally ignores Andrew's unintelligible one-word interruption in line 96 which can be interpreted as not ceding him the floor, she still requires his active attention and listenership⁴ – and that of other students – as she gazes at him (and later at Jaume) while continuing her utterance (lines 97-100). To illustrate her argument she first provides quite a generic example of benefits some of these single-celled microorganisms can bring people by launching the idea of their use for food production (**we can use them <to make some food>**, lines 97 and 99). The importance of the fact, that is, the usefulness of certain bacteria, is highlighted by slower speech pace accompanied by the emphasis on the word 'food' (line 99). Note here that the teacher again employs a 'we'-statement in her utterance.

The teacher moves on and uses another (re)mediation strategy as she introduces a concrete object from the outside-the-classroom context: she makes an explicit reference to 'Actimel'⁵, a yoghurt-like drink. Being taken from everyday life, this proper noun most probably results familiar to the class. However, to bring her explanation even closer to the students, the teacher directly addresses them and offers a definition of Actimel (**do you know Actime::1, e: e1- this yoghurt, that e:**, lines 103 and 107), though incomplete. The item to be defined is mediated, after a hesitation and a false start (probably in L1), by the token

⁴ Chapter 6 will explore in detail how active attention and listenership, among other phenomena, are interactionally accomplished in this CLIL classroom.

⁵ 'Actimel' ('DanActive' in USA and Canada) is an internationally famous brand of a yoghurt-like drink within the 'Danone' line that has been actively promoted on Spanish TV for several years and that is widely consumed at the national and local levels.

'yoghurt' which denotes a more general category. The following 'that' was probably meant to introduce elements and features specifying the defined item within the category (Dalton-Puffer, 2007) but it is followed instead by a short hesitation.

Prosody and non-verbal elements that accompany the teacher's utterances provide more details: her low-rising intonation in lines 99 and 103 implies continuation. The same interactional orientation to proceed is conveyed by her 'counting' gestures in lines 101 and 105 which indicate that she may have intended to provide a few easily recognizable and comprehensible examples from the students' everyday life and in this way enrich her explanation. Despite a notable change in the syntactic structure in line 107, the teacher seems to continue steadily with the line of argument she has developed so far. After a false start in line 107, she goes on constructing the example of Actimel. With this aim, in line 109 she uses apparently highly academic reifications – 'lactobacillus' and 'casei immunitas'. Despite their scientific (and thus dense) nature and a supposedly opaque linguistic form, these Latin terms however, and most probably, have been borrowed by the teacher from a popular TV commercial and the yoghurt's packaging as taken together – 'Lactobacillus Casei Immunitas' – they actually make up the name of one of the main yoghurt cultures comprised in Actimel. Later on, Jaume and Miquel's interventions in lines 118 (Excerpt 4.5) and 128 and 133 (Excerpt 4.6), correspondingly, which contain one of the terms, namely, 'casei immunitas', may indicate that they in fact result familiar to (at least) these students.

Let us now have a look at the teacher's intervention: `not all bacteria cause ↓illnesses (.) there are some that are (0.5) beneficial| for| us|, for ↑example= [...] we can use them <to make some food>, do you know Actime::1, e: el- this yoghurt, that e: lactobacillu::s ↑tal or::: casei ↓immunitas:.` It can be seen that in such a long (9-line) intervention – in interactional terms –, the teacher has developed a piece of complex explanation through which she effectively carried out a number of actions. In particular, she has richly contextualized and clarified the meaning of the problematic item as well as introduced other related content terms and established semantic relations among all of them.

However, the teacher's falling intonation at the end of line 109 signals that her explanation is close to the end but is not concluded yet. This is actually confirmed by her next 'designedly incomplete utterance' (Koshik, 2002) in line 112: **all of these ↑are:** which she cuts off with a rising intonation and a slight stretching of the last word. In such a way the teacher opens a 'filling the gap' sequence by which she explicitly passes the interactional floor to the students and solicits their active co-participation in interaction (Lerner, 1995).

This pedagogical strategy is clearly captured by Ricard who has actually been soliciting the turn to intervene for the last 12.7 seconds which is evidenced by his hand raised during this prolonged period of time (first, in lines 102 and 106 and a moment later in lines 108, 111 and 114). Having been nominated by the teacher's gaze and nod in line 113, which are produced simultaneously with her purposefully unfinished utterance, Ricard skilfully completes her recapping utterance with highly emphatic **BACTERIA** (line 115). His enthusiastic contribution with which he demonstrates that he has acquired access to this subject-specific knowledge as a result of the teacher's explanation (Koole, 2010) is ratified as appropriate school-science reification by the teacher's concurrent nodding in line 116.

The teacher however does not only accept his intervention thus recognizing his display of knowing, she actually incorporates it into the on-going explanation. With the conjunction 'and' she links together her previous incomplete utterance (line 112) with that of Ricard (line 115, in green) and with her next utterance (lines 119 and 121) which results in the following co-constructed statement: **all of these ↑are: BACTERIA and they are good for us (.) for our digestive system for example.** In such a way she rounds up both her extended (re)mediation sequence on the example of Actimel and the prior statement that 'not all bacteria are harmful' but rather 'there are some that are beneficial for us'.

Here again the teacher uses remediation in reformulating this statement: she changes 'beneficial', one of the four key concepts in her explanation, to 'good' which is also marked prosodically (line 119), thereby bridging once more the two domains: that of academic discourse of CLIL science classroom and that of easily

understandable everyday English. She also adds another example of benefits of bacteria for humans, namely for digestive system, which is actually closely related to her earlier example of the yoghurt-like drink as the two bacteria present in it are regarded as very helpful for digestion. Moreover, she reinforces her verbal contribution with an illustrative pointing gesture (line 122). Here again the teacher opts for a 'shared' perspective by employing pronouns 'us' and 'our'.

Excerpt 4.6

123 *ric* *raises hand*

124 *tea* *looks at RIC, nods*

125 RIC: **harmful *xxxx (d'anglès?)**

Translation: harmful xxxx (in English?)

126 *ric* **looks at dossier, points at it with pen,*

127 *looks at TEA*

128 MIQ: ***(>a ver< casei immunitas)**

Translation: (>let's see< casei immunitas)

129 TEA: **perjudici↓al**

Translation: harmful

130 RIC, JAU: **[perjudi*↓cial]**

Translation: harmful

131 JOA: **[<perju>]dici↓al**

Translation: harmful

132 *ric, jau* **bend over dossiers, write down*

133 MIQ: **olé (.) casei immu*nitas (.) M::A**

134 *tea* **looks at MIQ, smiles*

In line 123, Ricard solicits the turn again which he is given by the teacher's nominating gaze and nod in line 124. For the second time he addresses the teacher with a de-contextualizing clarification request (line 125) on the opaque term 'harmful' (see Excerpt 4.2, line 66). Unfortunately, it is only partly intelligible: the problematic item and a short stretch of talk in the L1 which may be interpreted as a request for the provision of the term's translation to the L1 are the only elements that can be distinguished. The student however combines his verbal intervention

with a series of supporting non-verbal actions: he looks at his dossier, points at it with a pen and finally gazes at the teacher (lines 126-127). In this way he explicitly relates his discourse to the term appearing in the teaching materials and orients it towards a recognized expert in the classroom – the teacher.

In line 129, the teacher provides an expected response to Ricard's public request which is the de-contextualized translation of the concept to L1 (*perjudicial*). On the contrary to Excerpt 4.1, in which the class displays no signs of possible (non-) understanding of the same translation (see Excerpt 4.1, lines 18-20), here, Ricard and Jaume, the two students who have explicitly stated the opacity (and perhaps the density) of the item 'harmful' in Excerpt 4.2 and thus caused the teacher's extended explanation in Excerpts 4.3-4.5, echo the teacher by repeating the term's L1 counterpart (line 130). Overlapping with them, another student, Joan, does the same producing the first part of the word with clearly slower speech pace (line 131). Another evidence corroborating that this time the students have followed the teacher's highly contextualized and elaborated explanation and the term's meaning in the L2 (it can even be argued that in the L1 too) has been comprehended is the fact that Ricard and Jaume produce the second part of the L1 term while bending to jot down, presumably, the provided translation in their dossiers (line 132).

It has been already noted above that the seemingly scientific name of the bacterium ('Lactobacillus Casei Immunitas') that the teacher introduces into her explanation in line 109 does not actually sound so new and unfamiliar to the students. Thus, in lines 117-118 Jaume privately addresses his peer, Joan, and with a laughing intonation whispers him 'casei immunitas'. In line 128 Miquel produces the same marketing label preceded by an L1 interjection 'let's see' (>a ver<). Being unacknowledged by other participants, such private or semi-private turns of the students may still be regarded as uninvited demonstrations of understanding (see also Koole, 2010). And, finally, in line 133 Miquel intervenes again producing the label once more. This time however he does it in a much more enthusiastic way which is evidenced in an interjection *o1é* and in his prosodically highly marked, approving sound M: :A which effectively frame the label that rendered to be so successful and popular among the students. Both such an emphatic and informal

contribution of Miquel and the teacher’s reaction to it, that is, her gaze at him and a smile on her face, may be considered convincing signs that the interactional project has reached its end.

5.2.2. Summary and discussion

The sequential and multimodal micro-analysis of the six Excerpts (4.1-4.6) comprising interactional project 4 has shed light on the way the participants signalled and tackled cooperatively linguistic and conceptual obstacles caused by the opacity of the target language and the density of subject-matter content in this CLIL science classroom.

It is noteworthy that the extended teacher-led explanation emerged as *a consequence of the difficulty two students faced* in unveiling the linguistic opacity and/or content density of the concept ‘harmful’ basing only on their own resources and their decision to resort the problem to the officially recognized expert in the classroom, the teacher, by explicitly (and interactively) signalling the obstacle to comprehension. Of particular relevance here is the fact that the item has been previously treated by the teacher through ‘explanation by translation’ in Excerpt 4.1.

The analysis has also revealed a clear *path* that the teacher and the students followed in dealing with this opaque and dense item, in main part through the constructed dialogic explanation. The steps taken by the participants in each stage and presented in Figure 5.2-5 clearly indicate that the path was *primarily verbal, interactional and problematic*.

Stage	The procedure
1.	<i>Teacher de-contextualizes the item</i>
The teacher explicitly focuses on the term ‘harmful’ through a remediation sequence: (a) she elicits students’ previous knowledge about its meaning, (b) provides an accurate translation to the L1 and (c) offers an antonym in the L2 (Excerpt 4.1, lines 12-20). However, once the remediation sequence is over the class displays no signs of possible (non-)understanding.	

Stage	The procedure
2.	<i>Students de-contextualize the item</i>
	First, Ricard and Jaume try to tackle the obstacle by themselves in a private conversation. Having been unable to do it alone, they then publicly signal the problem by resending it to the teacher with a clarification request (Excerpt 4.2, lines 44-47, 50-53, 56-57, 59 and 62-63, 65-66). However, the very form of the question – ‘what is harmful?’ – makes no explicit reference to the origins of the problem, being it either L2 opacity of the concept or its content density, or both.
3.	<i>Teacher and students contextualize the item</i>
	As a consequence of the students’ active demand for clarification, in Excerpts 4.3-4.5 the teacher gradually constructs an extended school-science explanation that tackles the core school-science content by developing a complex line of argument and creating a semantic network among four subject-specific reifications (‘harmful’, ‘beneficial’, ‘illness’ and ‘infection’). It not only leads to the students’ understanding of the term, evidenced in their note-taking in Excerpts 4.3 and 4.4 (lines 72-75 and 81-85) but also promotes their participation in the process of the elaboration of the explanation (Excerpt 4.5, line 115). The result is a dialogic explanation built by several voices.
4.	<i>Students de-contextualize the item</i>
	Ricard again publicly problematizes the term by addressing the teacher with a de-contextualizing clarification request (Excerpt 4.6, lines 123-125).
5.	<i>Teacher de-contextualizes the item</i>
	The teacher provides the de-contextualized translation of the concept to L1 for the second time (Excerpt 4.6, line 129).
6.	<i>Students de-contextualize the item</i>
	Several students repeat the L1 counterpart and jot down, apparently, the provided translation (Excerpt 4.6, lines 130-132). In comparison, this did not happen in Excerpt 4.1 when the translation was given for the first time.

Figure 5.2-5. Interactional path taken by the participants for the resolution of the problem and the co-construction of the dialogic explanation

In tackling the problem cooperatively with the students and co-constructing the dialogic explanation, the teacher has been seen to deploy a range of

interactional scaffolding strategies and adjustments which displayed different components of her classroom interactional competence.

Thus, in relation to *the use of learner-convergent language*, throughout the development of the explanation the teacher frequently *built linguistic bridges* between target school-science discourse and everyday discourse in the L2. More particularly, she reformulated abstract terms into familiar ones, provided etymological and informal definitions, offered scientific and colloquial examples as well as introduced everyday-life objects that constitute shared knowledge into interaction. Such interactional strategies allowed her to gradually move from more general to more concrete while making the explanation progress.

By using different morpho-syntactic structures and lexical devices (e.g., antonyms, synonyms) the teacher was able to construct a chain of negations and assertions which, with their implicit and explicit contrasts and comparisons, strengthened the line of argument being developed. The same effect had her combination of prosodic elements (e.g., intonation, emphasis, sound stretching and speed of speech delivery) with well-measured pauses and non-verbal actions (e.g., gaze, gesture, head and body movement). They allowed her to mark important pieces of knowledge or key concepts and establish relations among them, all this aiming to favour the students' understanding of the opaque and dense L2 terms. In one word, such actions and adjustments helped her *elaborate an effective, student-friendly explanation*, thereby affording the class opportunities for the integrated appropriation of the target language and academic content.

The analysis has also provided insights into the teacher's *use of the L1*. In two different moments (Excerpt 4.1 and Excerpt 4.6) the teacher offered an L1 term '*perjudicial*' as an equivalent of the problematic L2 term 'harmful'. It has been already discussed (section 2.7.2) that such use of the languages available in CLIL classrooms, that is, the explanation of L2 lexical items through their translation into the L1, has been found to be a rather common strategy used by both teachers and students for the clarification of the meaning of unknown individual terms or concepts (Dalton-Puffer, 2007; Nikula, 2005).

A close examination of interactional project 4 has revealed however that the *mere provision* of the L1 counterpart of the de-contextualized term 'harmful' in Excerpt 4.1, through which the teacher seemed to deal with the comprehension obstacle as only a language problem, was a scaffolding strategy which at that moment did not prove to have an immediate success as it did not result in direct understanding of the item by the students. On the contrary, in Excerpt 4.6 the translation offered by the teacher *after* an extended and cooperatively constructed dialogic explanation in which the item was contextualized, exemplified and related to other concepts – introduced with the aim to build a common semantic network – rendered the students' explicit understanding of the item in the L2 and most probably in the L1 as well.

Such findings corroborate earlier research on teaching-and-learning in CLIL settings (e.g., Borràs, *et al.*, 2010; Gajo, 2007a; Gajo and Berthoud, 2008; Moore *et al.*, 2012) that has shown that in the process of un-densifying content knowledge bilingual teachers often employ reformulations and paraphrasing first which are then followed by translations. On the other hand, the analysis also contribute to better understanding of Dalton-Puffer's (2007) concerns about an observable overuse by CLIL teachers of explaining by translation 'which may be overestimated in its capacity to create full understanding. Offering an L1 label almost certainly creates a recognition effect but how is one to tell whether the students have a rich cognitive-semantic representation of the relevant word in their L1?' (*ibid*: 137).

It has also been found that the teacher created a different *deictic perspective* in each explanation through the use of personal pronouns (see Figures 5.2-6 and 5.2-7 below). In Explanation 1, the teacher checked students' comprehension of the term 'harmful' by addressing the class directly with a question which contained a second person pronoun 'you'. In this way she implicitly marked the distance between her and the students. Meanwhile, in Explanation 2 the teacher frequently employed first person plural pronouns 'we', 'us' and 'our'. This may be interpreted as her attempt to create *a greater sense of personal involvement* for the students and 'to construct *a joint shared version of educational knowledge*' (Mercer, 1995: 25, italics added). This supports Nikula's (2005) findings on the participants' tendency to work within a more immediate and personal deictic perspective in

CLIL settings when compared to EFL classrooms as well as on students' greater activity in making initiatives in CLIL classrooms.

TEA: do you know the word harmful? *gaze -> class* JAU: e:: *malas*? VAN:
 °xxxx° TEA: *perjudicial* *gaze -> AND* e? the opposite is beneficial.

Figure 5.2-6. Teacher's explanation 1 in Excerpt 4.1, lines 12-20

TEA: *gaze -> JAU, class* <harmful means that produce (0.3) harm (.) something bad for ↓us> for example (.) ↓illnesses (1.0) ↓infections (0.6) but (0.5) we don't e:: we haven't to think that all bacteria are ↓harmful (0.2) *gaze -> JAU, class* not all bacteria *headshake* cause ↓illnesses (.) there are some that are (0.5) *nod + pointing gesture -> herself* beneficial for us, for ↑example= AND: =xxxx TEA: *gaze -> AND* we can use them *gaze -> JAU* <to make some food>, *gaze -> class* do you know Actime::l, e: e1- this yoghurt, that e: lactobacillu::s ↑tal or:::: casei ↓immunitas: *gaze -> RIC + nod* all of these ↑are: RIC: BACTERIA TEA: *gaze -> class* and they are good for us (.) for our digestive *pointing gesture -> herself* system for example.

Figure 5.2-7. Dialogic explanation 2 in Excerpts 4.3-4.6, lines 68-122

So, the analysis carried out in this chapter has depicted a teacher who oversaw possible lexical problems which, according to her actions, could have impeded the students' understanding of the term in question due to its potential opacity in the L2 and who therefore initiated a trouble-shooting remediation sequence. More than this, however, the analysis has pointed to her *responsiveness* to the students' doubts and contributions. The emergence of such doubts and contributions in the analyzed dataset has revealed the teacher's *savoir faire*, or, in Treagust and Harrison's (2000) terms, pedagogical content knowledge, in the *facilitation of interactional space* to the students, yet loosing neither her initiative nor her guiding role in the elaboration of the dialogic explanation.

Though the teacher carried out the most of the explanation, the way how she organized and managed classroom interaction and her instructional choices in the form of discourse adjustments and non-verbal resources allowed her to share the interactional floor with the students (see also Escobar Urmeneta and

Evnitskaya, 2011). In this way the teacher afforded them *opportunities to participate* in classroom interaction by asking their own questions, to *contribute* to the co-construction of the explanation as well as to *develop* their L2 lexical-discursive repertoire through the very act of participating.

5.3. CHAPTER SYNTHESIS AND GENERAL DISCUSSION

The micro-analysis of interactional project 4 presented in this chapter has also raised a number of issues worth to discuss.

First, the value (and perhaps sometimes the necessity?) of *students' private turns* in teacher-led activities. Some researchers argue that students' side-talk often represents the only opportunities for individual students to get clarification or support from their peers or to practice what they want to say without overt face threatening (e.g., Olitsky, 2007). 'Students first share their question, or confusion, or idea with another student, and only then do they go public with it and ask the teacher' (Lemke, 1990: 75-76). However, if dealt with appropriately by teachers rather than sanctioned or overlooked, such private turns may become interactional spaces for legitimate peripheral participation 'that students could consider meaningful and relatively free of risk' (Olitsky, 2007: 38). They may also eventually transform into explicitly and publicly stated students' questions, requests of clarification or repetition, demands for help, comments, etc., leading hence to their increased and real participation in classroom interaction.

In the data examined in section 5.2.1 it has been observed that a private conversation between Ricard and Jaume served both students as a preparation phase to become ready to publicly resent a question to the teacher on the problematic term that had already been treated publicly in class. The fact that they finally decided to resort to her and did it in the target language indicates that they felt comfortable enough to overtly show their lack of understanding and demand teacher's help in the L2. This goes in line with Nikula's (2005) study which shows that even within teacher-led activities Finnish CLIL students make public questions to the teacher more often and more readily than in regular EFL classrooms.

Second, the analysis has evidenced different agendas and teaching-and-learning rhythms present in this CLIL science classroom (see also Koole, 2007). Thus, the teacher considered that the remediation sequence related to the problematic L2 item had been sorted out thanks to explaining by translation and the provided antonym. Meanwhile, a private interaction between the two students thirty lines later (approx. 20 seconds) has revealed that in fact the concept (in the L2 and most probably in the L1) still remained both opaque and dense for (at least) these two students, none of whom had displayed (non-)understanding in Excerpt 4.1.

However, such reflections cannot lead to a conclusion that the first teacher's attempt to call the students' attention to the (at that moment, potentially) problematic term and thus to remediate it together with the class was useless as it is legitimate to ask oneself whether the students would have noticed their gap in respect to the item in question if the teacher had not focused on it in the first place. Another evidence of the co-existence of different teaching-and-learning rhythms in the classroom is the three separate occurrences of the marketing label 'casei immunitas' within the dialogic explanation. Hence, while being first introduced by the teacher as part of the example of Actimel it is later reproduced by two different students (privately by Jaume and publicly by Miquel).

Third, the sequential and detailed data exploration in this chapter problematized Gajo's (2007a, 2007b) dichotomous presentation of the concepts of opacity and density. Though admitting that 'the very idea of integration excludes any clear-cut contrast between linguistic elements and non-linguistic elements' (ibid: 578), Gajo still quite clearly distinguishes between the instances in CLIL classroom interaction which give priority to L2 opacity and those which give it to content density, thereby leading to the separate functioning of the processes of remediation and mediation.

If confirmed in further studies, the findings discussed above might challenge this dual view. More particularly, the fact that the most of interactional work that took place during the dialogic explanation dealt with problems that had emerged precisely due to *a dual (and integrated) focus* on teaching-and-learning of

dense subject-specific content through the opaque L2 suggests that the dichotomy presented by Gajo (2007a, 2007b) needs to be taken with precaution as it might lead to an oversimplified understanding of the processes of mediation and remediation in the CLIL classroom. On the contrary, the analysis has disclosed that the sequences of mediation and remediation are *highly and reflexively interwoven and constantly support one another* so that work on density provides a context for work on opacity and vice versa and such intertwining and interdependence can be mainly observed at lexical and discursive levels.

Although there is obviously no way to prove it, it may yet be tentatively suggested that an interactional project similar to the one analyzed in this chapter would have unlikely taken place in an L1 classroom, as teachers (and perhaps students) might have relied in excess on the sharing of a ‘common’ and ‘transparent’ semiotic resource: the L1. What is clear here is that the extreme care that the teacher and the students took in monitoring (language) comprehension positively affected the understanding of the concepts being tackled. This occurred through the co-construction of the dialogic explanation in which the problematic item was defined, exemplified, contextualized and situated within the semantic network together with other key concepts.

So, the findings strongly suggest that CLIL science classrooms are susceptible of becoming environments where:

1. The process of constructing science explanations is dialogic in which the sequences of mediation and remediation are highly interwoven and support one another since they allow the teacher to enhance students’ understanding of the content which has been problematized by the students themselves due to its conceptual density and/or linguistic opacity in the target language, and thus overcome both conceptual and linguistic obstacles;
2. The processes of the de-contextualization and re-contextualization of the interactional focus on lexical items turns out to be an effective pedagogical strategy for L2 teaching in the CLIL classroom as, for example, what emerges as a lexical problem signalled initially by the teacher is sorted out

by means of a dialogic science explanation triggered by the students' signal of the problem.

CHAPTER 6

STUDY 3: DOES BEING 'SILENT' MEAN NON-PARTICIPATION IN THE CLIL SCIENCE CLASSROOM INTERACTION?

6.1. CHAPTER OVERVIEW

This chapter will present a close examination of interactional project 5 entitled *Different levels of organization of human body* which deals with the data collected in session 3 (see section 3.4.3.3). The analysis is lead by the following research questions:

What are the varied ways of participating in the interactional accomplishment of the joint elaboration of dialogic explanations of the so called 'silent' students'?

What multimodal resources do such students mobilize in order to achieve their interactional goals, that is, to display their gains in the understanding of key aspects of the subject-specific knowledge being co-constructed in the L2 and/or make their contributions to that joint process?

It uses the constructs of *participation* and *interactional competence* in order to identify and describe traits of interactional competence in the target language displayed by the students in the observed CLIL science classroom in the process of joint construction of dialogic explanations, with a particular focus on those students who remain silent.

Additionally, attention will be paid to the identification and portraying of the teacher's classroom interactional competence which she deploys in the process of constructing dialogic explanations.

6.2. INTERACTIONAL PROJECT 5: *DIFFERENT LEVELS OF ORGANIZATION OF HUMAN BODY*

Session 3 was dedicated to the classification of living beings into different groups, from the broadest to most specific one (kingdom, phylum, class, order, family, genus, and species). It covered the following teacher-led whole-class activities and subject-matter content:

1. Homework assignment (handout):
 - 1.1. The teacher provided brief instructions and modelled how to carry out a ‘hands-on’ activity on different levels of organization of human body which was designed to review previously covered content.
2. Two central activities on new content (dossier):
 - 2.1. Students read aloud in turns a text in the dossier which explained that living beings can be classified into different groups (kingdom, phylum, class, order, family, genus, and species). The teacher checked students’ comprehension of new vocabulary and extended the text;
 - 2.2. Students carried out a practical activity on the new topic (groups of classification of living beings) in which they had to cut images of different animals and paste them into the corresponding group in the dossier.

Interactional project 5 corresponds to activity 1 in which the teacher used the following handout (see Figure 6.2-1 below for a small-scale size; see also Appendix 5 for the original size):

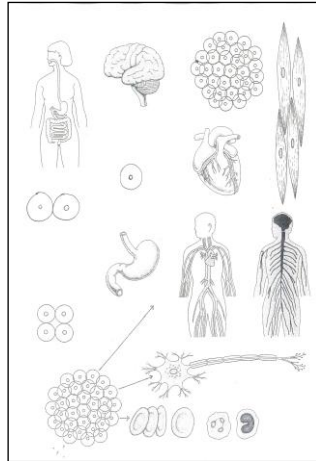


Figure 6.2-1. Handout used in interactional project 5

6.2.1. Analysis

The participants in this interactional project are the teacher (TEA) and the following students: Andrew (AND), Arnau (ARN), Carla (CAR), Enric (ENR), Jaume (JAU), Joan (JOA), Miquel (MIQ), Quim (QUI) and Tatiana (TAT). Figure 6.2-2 presents the spatial distribution of the majority of the participants in Laboratory 1¹.

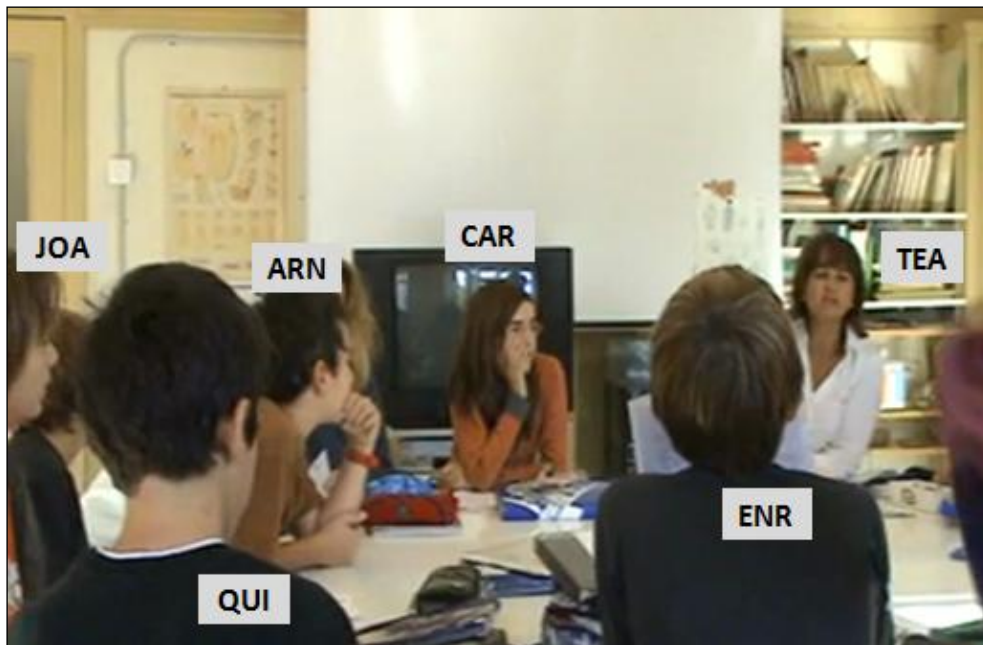


Figure 6.2-2. Spatial distribution of the participants in interactional project 5
(Figure corresponds to Excerpt 5.4, lines 64-65)

¹ Andrew, Jaume, Miquel and Tatiana cannot be seen in Figure 6.2-2 due to the position of the camera.

The interactional project takes place at the very beginning of the lesson and, with the aim to facilitate the comprehension of the analysis, has been divided into five shorter Excerpts (5.1-5.5). It starts with the teacher taking the handout (see Figure 6.2-1 above) and showing it to the class. Miquel and Arnau attempt to suggest what the handout is about (Excerpt 5.1). The teacher accepts Arnau's answer, confirming that the handout contains main elements which constitute human body and which can be organized into different levels, and explains that the handout is a homework assignment for the next session (Excerpt 5.2). Then, the teacher explains that in carrying out this 'hands-on' activity the students have to follow a text in their dossiers which they worked on in one of the previous lessons². After that, she models the initial part of the activity (Excerpt 5.3) and then asks the class to continue. Several students volunteer and provide their answers (Excerpt 5.4) which the teacher accepts and expands (Excerpt 5.5).

Excerpt 5.1 begins with the teacher addressing the class:

Excerpt 5.1

1. **TEA:** today I'm going to give ***you this** (1.5)
2. *tea* **fig5.1-a lifts handout,
looks at class-right*



*
Figure 5.1-a

3. ***and what's this?**
4. *miq* **looks at handout in TEA's hand----*
5. *** (0.6)**
6. *miq* **fig5.1-b leans towards TEA----*

² This lesson took place before the data collection.



*

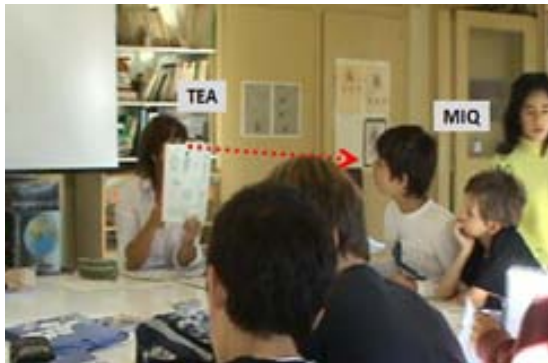
Figure 5.1-b

7. **MIQ:** e::*::*

8. *miq* ----->*

9. **ARN:** *a:::

10. *tea* *fig5.1-c looks at MIQ----



*

Figure 5.1-c

11. **ARN:** a::: *levels *of organism of human- *human body*

12. *miq* ---> *fig5.1-d lowers gaze,
looks at his notes

*fig5.1-e turns away, looks
at newly arrived student



*

Figure 5.1-d



Figure 5.1-e

13. *tea* ----->*abruptly turns to ARN, looks at him----->*

In lines 1-3 the teacher establishes a 'whole-class floor' (Jones and Thornborrow, 2004) as she announces the beginning of a new teaching activity (today I'm going to give you this) and orients her gaze towards the students

on her right. She contextualizes the activity to be explained by employing an emphasized deictic 'this', thereby making an explicit reference to a relevant material artefact – a handout – which she holds in her hand and lifts up to make it more visibly accessible to the whole class (line 2, Figure 5.1-a). However, she does not specify what the handout or the activity itself is about but rather requires the students to provide the necessary information about it (*and what's this?*, line 3), thus passing them the interactional floor.

The following lines uncover how one of the students, Miquel, struggles to get the teacher's attention in order to project himself as a potential next speaker. During the teacher's request in line 3, he gazes at the handout in her hand (line 4). By orienting to the relevant artefact for the announced activity in line 1, Miquel produces a sequentially appropriate action. In such a way he also displays his *attentiveness* to the ongoing interaction.

More noticeable is his move forward with his body towards the teacher in line 6 (Figure 5.1-b). This move is coordinated with the turn-transition relevance place (TRP) at the end of the teacher's question and occurs during the pause of 0.6 second where a student is expected to provide an answer. In the light of the opportunity for a speaker change, both his specific body movement and its timing embody an upcoming turn-taking. Having projected this, he then actually attempts to launch a turn (and therefore position himself as a potential current speaker) with an extremely stretched hesitation marker *e: : : :* (line 7) while still looking at the handout (line 8). Such multimodal actions seem to be successful enough: sitting at the common table on the left of the teacher, he finally obtains her attention (line 10). Having been looking at the other part of the class throughout lines 1-9 (see the teacher's gaze orientation in Figures 5.1-a and 5.1-b), the teacher shifts her gaze to Miquel (see Figure 5.1-c) and keeps it on him for some time (till line 14). In this way she non-verbally acknowledges and ratifies his attempt to become the next speaker.

The fact that Miquel has not only maintained his gaze at the handout for more than 1.0 second but also put himself physically closer to it by leaning forward allows us to make two tentative observations. First, that he may have been trying

to find something on the handout that would give him some clue to what it or the activity was about. And second, that his prolonged stretching of the hesitation marker has allowed him to gain extra time for delivering the answer. His subsequent embodied actions in line 12 however point to his gradual withdrawal from the gained 'speakership' (Sacks, 1992). First, he seems to momentarily relinquish the interactional floor as he lowers gaze to check his notes on the table (Figure 5.1-d). He completely resigns when he turns his head away from the teacher and looks at a student who has just arrived (and who arranges herself relatively close to him), thus definitely positioning himself outside the established interactional frame (Figure 5.1-e).

Meanwhile, another student, Arnau, also struggles to participate and provide his candidate answer. In search for the teacher's attention (who is looking at Miquel), he produces a stretched hesitation marker **a: : :** (line 9) which overlaps with Miquel's multimodal conducts in lines 7-8. Then Arnau produces another prolonged hesitation (**a: : :**, line 11) which is followed by his self-selected attempt to get the floor directly as he offers his candidate response in the target language: **levels of organism of human- human body** (line 11). His positioning as the current speaker is ratified by the teacher as she abruptly reorients her gaze towards him in line 13 while he delivers his turn.

Several important interactional aspects can be highlighted here. In the first place, it is precisely during Arnau's turn (line 11) that Miquel reorients his gaze twice: first, from one artefact to another, that is, from the handout in the teacher's hand to his notes on the table, and, second, from the second artefact (his notes) to his classmate. Such *gradual withdrawal of his gaze* from the established interactional frame eventually leads to his *resignation of the floor* that has been implicitly granted to him by the teacher's gaze. In the second place, Arnau starts his intervention without having the teacher's attention who is still looking at Miquel; but he *does get hold* of her (gaze and) attention in the process of the delivery of his answer (see lines 11 and 13). And finally, the teacher's shift in gaze from one candidate respondent to the other is *coordinated* with Miquel's momentary withdrawal from the interactional frame through his gaze lowering

and Arnau's verbal attempts to gain her attention in order to put his candidate response forward (see lines 11-13).

In regard to Miquel, the analysis suggests that his abandonment of the interactional frame may have been conditioned by the toughness of the very interactional situation. As Miquel has been non-verbally acknowledged by the teacher as the next speaker and given the floor, he is under the pressure to provide his candidate answer. However, his hesitation in providing the answer becomes an *opportunity* for someone else to attempt to get the floor: Arnau, who is ready to offer his candidate response.

So, through the change in her gaze orientation (line 13), the teacher acknowledges Arnau's self-selection as the next speaker and his getting of the interactional floor. In Excerpt 5.2 she also officially ratifies his contribution verbally:

Excerpt 5.2

14. **TEA:** **these are the different levels of organization**
15. **of your ↓body (1.0)**
16. **and you will have to do *this activity at home.**
17. *tea* **lifts handout higher, looks at class*
18. **ARN:** **at home?**
19. *tea* *briefly gazes at ARN*
20. **TEA:** ***yes.**
21. *tea* **nods*
22. **ARN:** ***xxxxxxxxxxxx**
23. *tea* **looks at ARN *shakes head*
24. **TEA:** ***↓no:::**

In line 14 the teacher ratifies Arnau's contribution by reformulating it into a more written-like academic target language (**these are the different levels of organization of your ↓body**, lines 14-15). At the same time, she brings such academic L2 discourse closer to the students as she replaces the technical and

abstract terminology 'human body' with a denomination '*your* body' which, apart from being more concrete, also renders much more physical and emotional proximity. She then addresses the whole class by providing further information about the activity, namely, that it is a homework assignment (line 16) while looking around the classroom supposedly to check the students' comprehension (lines 17).

Arnau's clarification request **at home?** (line 18) is acknowledged by the teacher both in embodied (a brief gaze and a nod, lines 19 and 21) and verbal ways (a short confirmation, line 20). Second Arnau's utterance (line 22) stands as unintelligible in the transcript but seems to have been heard by the teacher. This is evidenced in her multimodal actions: she again sanctions his contribution with a gaze which is followed, this time, by double negative feedback (a headshake and a stretched negative particle) in lines 23-24. In other words, the *subtle timing* of the actions accomplished by Arnau and the teacher in relation to one another shows to what degree the students' participation in classroom is *interactionally constructed* (see also Koole, 2007): Arnau's successful getting of the floor is a result of him positioning himself as a legitimate possible next speaker in a sequentially appropriate way and the teacher's explicit recognition of him as such.

Excerpt 5.3 takes place 10 seconds later during which the teacher briefly explained what exactly the students had to do at home, namely, to put the images from the handout in order according to the text they had worked on in the previous session, and started to model the activity:

Excerpt 5.3³

40. **TEA: the first one is *↓this (.) a single cell (1.0)**
 41. *tea* **points to image on handout*
 42. **when this cell ↑divided (.)**
 43. **it *(1.3) becomes *^{fig5.3-a}(0.7) two cells,**
 44. *tea* **points to another image*

³ Excerpts 5.3 and 5.4 have been presented at the TRICLIL 2012 International Conference (Evnitskaya and Pochon-Berger, 2012).

45. *car,*
tat,
miq,
and



Figure 5.3-a

46. **TEA:** \uparrow next *division=
47. *tea* **points to another image*
48. **ARN:** *fig5.3-b= \downarrow four cells
49. *arn* **shows four fingers*



Figure 5.3-b

50. **TEA:** four cells,
51. **ARN:** \downarrow eight
52. **TEA:** *fig5.3-c afte::r (0.5) some \uparrow divisions (.)
53. *tea* **makes round gestures in air*
54. *joa*

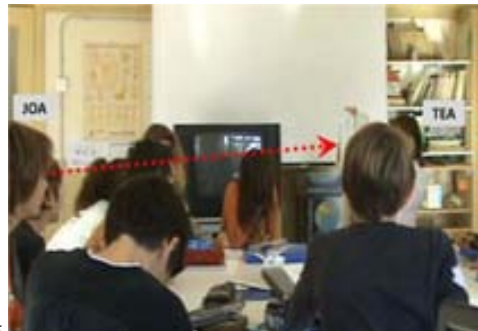


Figure 5.3-c

55. **TEA:** *a ball of \uparrow cells (0.7)
56. *tea* **circles another image*

The teacher models the students the procedure to follow at home by pointing to different images on the handout (lines 41, 44 and 47) and explaining the process of cell division: **the first one is ↓this (.) a single cell (1.0) when this cell ↑divided (.) it (1.3) becomes (0.7) two cells, ↑next division** (lines 40-46). It can be noted that apart from supporting her verbal message visually through pointing gestures she also reinforces it with a series of pauses of different length (from micro-pauses of less than 0.2 second to a notable one of 1.3 second) and the emphasis on key words ('this', 'cell', 'divided', 'becomes' and 'two'). In such a way she aims to guarantee the students' understanding of her explanation.

In line 45 at least four students (Carla, Tatiana, Miquel and Andrew) explicitly display their orientation to the teacher, her pointing gesture and the artefact in her hand (the handout). This is evidenced in their gaze direction as well as their head and body position (Figure 5.3-a). In case of Miquel and Andrew this orientation to the current speaker is even more notable since they incline their bodies towards the teacher in order to be able to see better what she is exactly pointing at. Through such embodied actions the four students overtly display their *close attentiveness* to the teacher's talk and therefore their *participation* in the current teacher-led activity.

In lines 48-49, Arnau, a student who is sitting on the right to the teacher, attempts to contribute multimodally to unfolding interaction: while looking at the handout, he utters **four cells** which he accompanies with a concurrent iconic gesture by showing four fingers (Figure 5.3-b). His intervention is precisely timed and sequentially appropriate because it occurs at the first occasion of the possible TRP: in his turn he provides an anticipated completion of the teacher's turn (line 46, **next division**) and her pointing to the image of four cells in the handout (line 47). Apart from being appropriate from the perspective of the sequential organization of interaction, both his utterance and gesture follow a scientific pattern of cell division initiated by the teacher (**TEA: single cell -> TEA: two cells -> ARN: four cells**). This last observation is confirmed by his second intervention in line 51 (**eight**).

61. *car,*
joa



*

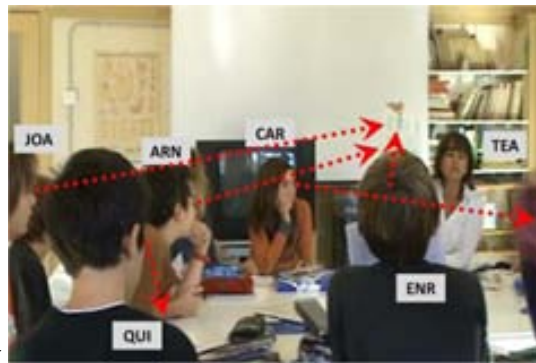
Figure 5.4-a

62. **ARN:** *ye:s*

63. **SS:** *ye:s*

64. **TEA:** *^{fig5.4-b}from this ↓ball (0.5) what happens?

65. *joa,*
arn,
car,
enr,
qui

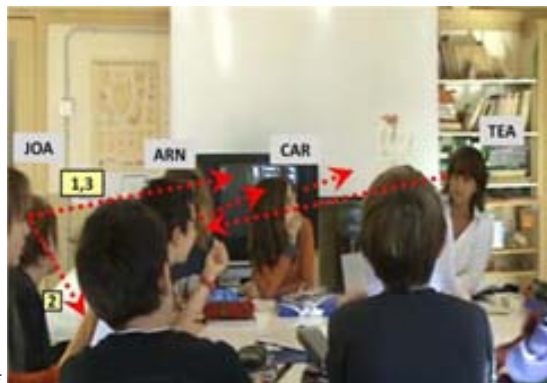


*

Figure 5.4-b

66. **ARN:** *e::hr a::ner-* a *^{fig5.4-c}neuron ↑cells

67. *joa,*
arn,
car



*

Figure 5.4-c

68. **JAU:** *a neu:::* [a ↓neu:::*^{fig5.4-d}ron]

69. **ARN:** [a a neuron::] °↑cells°=



*
Figure 5.4-d

In line 57 the teacher addresses the class uttering **an:d (.) can anybody** (0.5) **↑follow (.) the explanation?** At the first glance, the verb used by the teacher ('follow') sounds ambiguous in this interactional context and could rather be interpreted as a comprehension check, something like 'do you understand the explanation?'⁴ However, her non-verbal actions in lines 58-59 and their precise timing with her utterance speak to the contrary. First, she simultaneously briefly gazes at the handout and lifts it up to make it more visible and accessible to the whole class exactly at the moment when she utters the word **can**. And, second, she looks at the students in front of her while saying **anybody**.

Such coordination of the teacher's multimodal actions indicates that she is searching a 'volunteering speaker' (see e.g., Fasel and Pochon-Berger, 2010; Mortensen, 2008) both through her gaze and gesture and talk. At this moment she does not require any more the students' attentive listenership but rather expects them to get the floor and display their knowledge (Koole, 2010). The fact that she addresses the whole class (**can anybody**) rather than individual students may indicate that the teacher promotes the practice of students' self-selection as next speakers and therefore corroborates what has been found in Excerpt 5.1. At the same time, the teacher's actions also point to her explicit shift from the elaboration of a monologic explanation to a more dialogic one.

In the next lines it can be observed how several students react to the teacher's call to continue her explanation. Thus, when the teacher lifts the handout

⁴ The author would like to thank Jill Simon for having drawn her attention to this issue in a data-session within DALE-APECS project in which the given excerpt was exposed and discussed (Simon Auerbach, 2012, personal communication).

in line 59, Carla also raises her head in order to readjust her gaze on the artefact placed higher than before and continues looking at it (line 51, Figure 5.4-a). She therefore keeps displaying her close attentiveness to the teacher's actions but shows no attempts to project speakership and take the floor.

Meanwhile, Joan accomplishes a different embodied action: he lowers his gaze (line 61, Figure 5.4-a). Two tentative interpretations can be proposed. On the one hand, he may have reoriented his gaze in order to look at or read something in his dossier, most probably in search of an appropriate candidate answer. On the other hand, it should be noted that in line 54 (Excerpt 5.3, Figure 5.3-c), that is, during the teacher's monologic explanation, Joan has his gaze oriented to the teacher and the handout she is holding up, but that he reorients his gaze precisely when the teacher expects the students to volunteer an answer. This fact may be interpreted as his *unwillingness* to take the interactional floor. If this was the case, then the precise timing of his action discloses his moment-by-moment monitoring of the unfolding talk and of the interactional procedure through which the teacher selects the next speaker.

In lines 62-63, Arnau and some unidentified students unanimously provide short but direct verbal affirmations (**ye:s**) which seem to indicate that they have understood the teacher's question 'and can anybody follow the explanation?' (lines 57-60) in the right way and can carry on with the explanation. Having obtained a confirmation, the teacher in turn narrows down her open question and orients it to the school-science knowledge that she wants students to construct within the explanation: **from this ball (0.5) what happens?** (line 64).

Line 65 evidences the way how the students *align* with different interactional events occurring simultaneously in the classroom. For example, Carla, who raised her head in line 61 and readjusted her gaze at the handout (see Figure 5.4-a), again moves her head slightly in order to shift her gaze (line 65, Figure 5.4-b) to some students at the other side of the classroom who, presumably, answered chorally to the teacher's request (line 63). Through precisely timed changes in her head position and gaze, Carla displays her participation in the classroom

interaction as she *constantly and sequentially monitors* who the current speaker or speakers are and what they do at each moment.

Meanwhile, Joan, Arnau and Enric clearly orient their heads and gazes towards the handout in the teacher's hand (line 65, Figure 5.4-b), perhaps because her question in line 64 was directly related to the image in it. From the very beginning of interactional project 5 and through the teacher's actions, this artefact became highly relevant for the construction of the teacher-led explanation. Hence, the students' orientation to it displays their *alignment* with the on-going teaching-and-learning activity.

On the contrary, the fact that Quim looks down at his dossier on the table (line 65, Figure 5.4-b) may reveal his *disalignment* with this whole-class activity. However, as it has happened with the interpretation of Joan's gaze withdrawal in line 61, Quim's action can also be understood as his sequentially appropriate action of seeking a candidate answer in the dossier in order to provide it publicly to the teacher.

Finally, it is Arnau who takes the interactional floor offered by the teacher. However, he is situated on the right side from the teacher and is hence outside her current visual field (see Figure 5.4-b). To project speakership he first attempts to get her attention with a series of short hesitation markers (**e**: :**hr** and **a**: :, line 66). Such attention-calling device seems successful enough because his projection is acknowledged by the teacher's gaze in line 67 (Figure 5.4-c). Having been granted the floor, he starts his actual turn and provides his candidate answer with a slightly rising, vacillating intonation: **a neuron** ↑**cells** (line 66). Another student, Jaume, joins the on-going interaction and takes the turn by offering an alternative answer (**a neu**: :: **a** ↓**neu**: :: **ron**, line 68). Jaume's contribution is close to that of Arnau but it contains a more appropriate subject-specific term ('neuron', instead of 'neuron cell'). His turn is partly overlapped with Arnau's second attempt (line 69) in which the latter repeats his prior candidate answer.

A micro-analysis of other students' gazes and postures in lines 67 and 70 reveals that they continue pursuing their learning agency and closely monitor the way classroom interaction develops through the contributions of their peers. This

is seen in Carla's new shift of gaze back to the handout (line 67, Figure 5.4-c), being this coordinated with Arnau's first candidate answer to the teacher's question. Such a sequentially appropriate embodied action of Carla may be interpreted as her intention to correlate her peer's answer with the corresponding image on the handout in the teacher's hand. Finally, during Jaume's (and Arnau's second) intervention (lines 68-69), the teacher points to an image on the handout (which can supposedly be the image of a neuron) and Carla follows the teacher's pointing gesture with her gaze (line 70, Figure 5.4-d). In both cases the student not only displays her *close attentiveness* to unfolding interaction but moreover *aligns and synchronizes* her own actions with those of other participants through the changes in gaze orientation and head position.

Apart from Carla, Joan also reorients his gaze. He does it quickly during Arnau's first contribution: having been looking at the handout (Figure 5.4-c, see gaze 1 in Joan's gaze orientations), he then looks down at his dossier (Figure 5.4-c, see gaze 2) and finally back at the handout (Figure 5.4-c, see gaze 3). The same interpretation as in case of Carla can be done, namely, that he tries to establish a relationship among the image in the handout, Arnau's candidate answer and, perhaps, his own notes or some information provided in the dossier.

In line 71 the teacher explicitly acknowledges and accepts Arnau and Jaume's candidate answers:

Excerpt 5.5

71. **TEA:** **=*yes.**
72. *tea* **points to image*
73. **TEA:** **some cells become specia↑lized (.)**
74. **they change (.) ↑sh:ape (1.2)**
75. **and (0.5) *they become**
76. *tea* **moves finger over last row of images*
77. ***for example *↑nerve cells of- or neurons.**
78. *tea* **points to image*
79. *tea* **looks at ARN*

The teacher does it with a short **yes** and a pointing gesture to the corresponding image (lines 71-72), immediately after Arnau's second intervention. Still, she not only accepts the students' contributions, she also incorporates them into the unfolding talk as part of the dialogic explanation. So, first, she reformulates their concrete example of a neuron into a complete school-science statement which conveys a more generalized meaning: **some cells become specialized** (line 73). Second, she clarifies her statement by paraphrasing it into a more familiar register in the L2: **they change (.) shape** (line 74). It should be noted that in both cases she emphasizes the key words, that is, 'specialized' and 'shape'. This allows her to establish an explicit causal relationship between two pieces of academic knowledge: the specificity of certain cells due to their ability to change their shape.

And finally, the teacher states that some of these specialized cells can become neurons (lines 75 and 77), while making reference to the images of specialized cells in the handout (line 76) and then pointing to a certain image (line 78). The example of the specialized cell provided by the teacher not only directly links her elaboration to the students' contributions but also repairs Arnau's candidate 'neuron cells' into 'nerve cells' and incorporates Jaume's candidate 'neuron' (line 77), thereby affording the whole class two pieces of appropriate school-science terminology.

6.2.2. *Summary and discussion*

The sequential and multimodal micro-analysis of interactional project 5 has shed light on the students' varied ways of participating in interaction in this CLIL science classroom and hence on their interactional competence in the L2.

So, the detailed examination of Excerpts 5.1 and 5.2 has revealed how two students, Miquel and Arnau, displayed their participation in the on-going classroom activity, that is, the teacher's questions and instructions on the homework assignment. In particular, Miquel attempted to *establish a common interactional space* with the teacher mainly through his body positioning (see also Kupetz, 2011) and thereby *project speakership*. Meanwhile, Arnau accomplished a

series of more 'vocal' actions with which he aimed at *positioning himself as a potential next speaker* and even achieved to become *the current speaker*. In this way both students explicitly demonstrated their *willingness to speak*. However, to reach such interactional goal successfully, they first needed to obtain the teacher's attention and ratification of their attempts of turn-taking.

Therefore, Miquel and Arnau deployed *a range of multimodal resources* (gaze, body movement, hesitation marker, verbal production) in accomplishing their actions. Namely, they (a) performed both verbal and non-verbal actions appropriate for this particular interactional situation, that is, attempts at providing candidate answers, and (b) coordinated such actions precisely with those of other participants. The findings also speak to the fact that, by applying participatory patterns of turn-taking that are alternative to traditional hand-raising, the students went beyond the mere display of their knowledge of the answer: what they actually aimed to was secure the teacher's attention and ratification when they took a turn (see also Mortensen, 2008).

Tracing other students' (mainly non-verbal) actions has also evidenced more subtle participation patterns existing in this classroom. Thus, Joan's gaze-shifting throughout Excerpts 5.3 and 5.4 has shed light on the way this student displayed his participation in unfolding interaction. Namely, by looking at the artefact (the handout) that was placed by the teacher at the core of her explanation, Joan displayed his close monitoring of on-going interaction and therefore his *attentiveness* to the current activity.

By looking successively at the handout, at the dossier and back at the artefact, Joan also revealed his *alignment* with unfolding talk through the triangulation of different sources of academic knowledge being co-constructed in interaction, that is, the image in the handout, Arnau's candidate answer and his own notes or information provided in the dossier. However, by withdrawing his gaze precisely at the moment when the teacher was looking for the next possible speaker, he also showed his *unwillingness* to project speakership and, as a result, his *unavailability* in that concrete instance to participate in classroom interaction.

Throughout Excerpts 5.3 and 5.4 another student, Carla, has also been observed to precisely and timely *align* her displays of orientation – through highly synchronized gazes and head movements – with the non-verbal actions and verbal messages of other participants. Such interactional coordination of her embodied actions with those of the others as well as her orientation to the relevant artefact (the handout) at the appropriate moments may serve as indicators of her *understanding and close monitoring* of unfolding talk, of the teacher and her peers' actions and of the dialogic explanation being co-constructed in the classroom.

Though not contributing overtly and 'vocally' (Duff, 2002) to the process, Carla still showed that she was actively engaged in the on-going teacher-led activity as *a legitimate peripheral (though silent) participant*. Such findings allow for a suggestion that the students' *active listenership* and *attentiveness* to the process of co-constructing dialogic science explanations accomplished (mainly verbally) by other participants in the CLIL classroom may also favour their learning of both school-science content and the target language.

Such findings reveal therefore that the students in the observed CLIL science classroom mobilized an array of multimodal resources in order to display different participation patterns, that is, to demonstrate their attention to, understanding of, alignment with and availability to the current teaching-and-learning activity, all these being demonstrations of their developing interactional competence (see Figure 6.2-3 below). They did it by accomplishing verbal and non-verbal actions which were highly synchronized with the unfolding talk. This means that these actions were not produced randomly anytime in the on-going activity. Rather, they were appropriately *timed* with the actions of other participants (the teacher and other students) as the students projected their speakership, took the floor or (re)oriented their gaze or head to the relevant artefacts or the current speaker at the appropriate moment in interaction.

Resource / Display of participation	Gaze / Gaze (withdrawal)	Gesture	Head position	Head movement	Body position	Body movement	Hesitation marker	Production in L2
Active listenership and attentiveness	X		X	X	X			X
Close monitoring of interaction	X			X				
Alignment / disalignment with interaction	X / X (w)		X	X				
Availability / unavailability to contribute	- / X (w)	X						
Willingness / unwillingness to provide an answer	- / X (w)					X		
Search for CS's attention							X	
Self-projection as potential NS						X	X	
Self-projection as potential CS							X	X
Self-projection as CS								X
Key: NS: next speaker; CS: current speaker								

Figure 6.2-3. Multimodal resources and participation patterns displayed by the students in interactional project 5

The students also displayed their developing interactional competence when they provided candidate answers to the teacher's questions at the precise moments when these were expected. In this way they showed their understanding of the context-specific patterns that rule the *sequential organization of interaction* (e.g., turn organization and turn-taking through TRPs, adjacency pairs and preference organization) and their close attentiveness to the unfolding talk, both being key in deploying effectively one's interactional competence. And finally, the students offered candidate answers in the target language which were appropriate both from the perspective of school-science and language, in such a way showing their understanding of the *topical adequacy* and their interactional competence in the L2.

One final aspect related to the students' participation in classroom interaction which emerged from the fine-grained analysis is worth of discussing. More particularly, it has been found that on some occasions the teacher *acknowledged* – in a precisely timed and sequential manner – certain ways of participation in the classroom displayed by the students while on others not. Thus, she acknowledged Miquel's mainly non-verbal attempts to project speakership (Excerpt 5.1) as well as both Arnau's much more vocal efforts to get the interactional floor and his verbal messages produced as a result of being acknowledged (Excerpts 5.1, 5.2 and 5.4).

The teacher also ratified Arnau and Jaume's verbal contributions from Excerpt 5.4 by officially accepting and incorporating them as part of her elaboration into the co-constructed dialogic explanation (Excerpt 5.5). The analysis has shown that such displays of participation have been acknowledged in part because the students effectively identified TRPs when the teacher was expecting (or more precisely, requiring) the emergence of a possible next speaker. However, the other multimodal contributions provided by Arnau (Excerpt 5.3) as well as much more subtle displays of alignment and attentiveness evidenced by Joan and Carla (Excerpts 5.3 and 5.4) were left un-acknowledged by the teacher.

Such findings go in line with those of Koole (2007) who shows that *what actually counts* as students' participation in classroom activities and *what not* is interactionally established by the participants, that is, by students' actions and teacher's acknowledgment or not of these actions. Therefore, an assumption may be put further that the teacher's acknowledgment or not of certain students' actions may reflect two interrelated factors.

The first one is related to the moment-by-moment development of the particular interactional context. That is, the emergence of possible TRPs within the unfolding talk which affords the students the opportunities to display their availability to take a more overt part in the on-going classroom activity by projecting their speakership or directly taking a turn-at-talk. Yet, this heavily relies on the way teachers deploy their *classroom interactional competence* and different

multimodal resources to either create or limit such spaces for students' learning and participation in the on-going interaction.

In interactional project 5 it has been found that on some occasions the teacher offered such interactional spaces to the students and promoted their self-selection as next speakers non-verbally through her gaze orientation, nod or headshake while on others she did it more overtly by stating rather open, 'inviting' questions or more refined and adjusted ones.

The second factor is the fact that more subtle forms of participation such as non-verbal displays of attentiveness to or alignment with the process of elaborating dialogic explanations are much more difficult to identify 'on-spot' in whole-class teacher-student interaction which may render highly multi-party. Therefore, the teachers' interactionally accomplished acknowledgment of the students' actions or its lack may have direct and practical consequences on their upcoming turn-taking and more vocal participation; the one which has usually counted as an appropriate way of participating in classroom interaction.

6.3. CHAPTER SYNTHESIS AND GENERAL DISCUSSION

Section 2.5.3.2 in the theoretical framework has already presented a discussion of several recent studies carried out on participation in classroom interaction within the field of general education and SLA. As it has been mentioned there, these studies have shown that the phenomenon of participation in classroom interaction is much more complex than it is usually represented in the traditional binary system of 'active verbal' participation versus 'passive silent' non-participation. What they have revealed is the existence of a number of more subtle forms of students' participation in the classroom which go far beyond mere 'verbal' contributions.

As a result, a number of 'labels' aimed at capturing elements constituting the phenomenon has been suggested, namely: 'displays of (in)attentiveness' and 'displays of orientation' (Bezemer, 2008), being 'silent' versus being 'vocal' (Duff, 2002), '(un)availability' and 'engagement' in multiple parallel activities (Koole,

2007), '(non-)recipency' (Sahlström, 1999) or 'displayed (non-)participation' (Sahlström, 2002). Even though the authors propose a variety of denominators to describe non-verbal actions of the students, it can be observed that each of them still tends to characterize such actions in fixed terms which offer only two possibilities of participation. It is clear therefore that each of the former studies has achieved to present only a fragmentary picture of the complex notion of 'participation'.

Considering the high relevance of the phenomenon and its particular role within the classroom context due to the fact that it is usually taken as a point of reference for legitimating and assessing students' outcomes, in this chapter an attempt has been made to overcome the present binary vision of the notion of 'participation' and, drawing on the sequential micro-analysis of interactional project 5, to further our understanding of the complexity of the phenomenon in question. Hence, what follows presents an analytical framework constructed on the basis of the findings discussed in the previous section. It is expected that the resulting framework will allow researchers to identify and characterize different participation patterns displayed by students in the CLIL classroom.

On the one hand, the analysis has confirmed earlier findings on the complex nature of the phenomenon since it evidenced different subtle ways through which students displayed their participation in the unfolding talk and on-going teacher-led activity. On the other hand, it has also provided important insights into the development of the topic because it has shown that participation can be manifested in a variety of embodied actions that actually display different *degrees* of involvement with the on-going interactional process of the co-construction of shared understandings and academic knowledge in the CLIL classroom rather than one definite type of participation or the other, as it has been suggested by earlier studies. Such findings let us forward an argument that participation in classroom interaction needs to be approached in an inclusive way and be conceptualized as a more *subtle, complex and gradual phenomenon* rather than a set of fixed categories.

Basing on different participation patterns which the observed students displayed interactionally and multimodally in the process of meaning making and

co-constructing the dialogic explanation in this CLIL science classroom, a tentative categorization of the phenomenon along the participation continuum is suggested (Figure 6.2-4). Therefore, the following stages have been proposed:

1. Stage 1: *Active listenership and attentiveness*. A student silently but closely monitors the sequential organization of unfolding interaction through the accomplishment of embodied actions (e.g., changes in gaze orientation, head and/or body position).
2. Stage 2: *Alignment*. A student precisely and timely coordinates their embodied actions with those of other participants.
3. Stage 3: *Availability to contribute*. A student accomplishes embodied and verbal actions which display their disposition to contribute to classroom interaction and the teaching-and-learning activity in progress.
4. Stage 4: *Willingness to speak*. A student accomplishes embodied and verbal actions which aim to attract the teacher's attention, project their speakership and get the interactional floor.

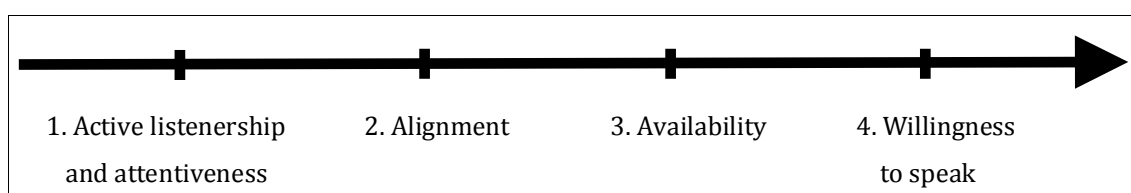


Figure 6.2-4. Participation continuum identified in interactional project 5

It is suggested that within this continuum, the emergence of more advanced levels of participation such as (3) *the availability to contribute* or (4) *willingness to speak* guarantees or at least assumes the presence of the previous stages. Yet, it is also argued that even the most subtle displays of participation such as *listenership* and *attentiveness* need to be considered legitimate ways of engagement in classroom interaction and activities.

Linking it to the CoP approach to learning, it can be suggested that the students' progress in acquiring and displaying higher levels of participation along the continuum from component 1 to 4 is actually their gradual movement from the peripheral to full participation in social practices of the CLIL science classroom.

Such conceptualization of the notion of ‘participation’ renders thus particular relevance for the understanding of participant patterns of those students who are usually treated as ‘silent’, ‘disengaged’ and ‘passive’.

Drawing on the analysis of embodied actions of ‘silent’ students in the interactional project 5 and within the limited scope of this study, it can be suggested that such students employ a range of non-verbal means (e.g., gaze, gesture, head position) in order to display on a moment-by-moment basis their attentiveness to on-going teacher-led activities as well as their orientation to relevant artefacts (e.g., handout, dossier, notes) and/or the current speaker. They also sequentially and appropriately align their actions with the unfolding talk and the actions of other participants. Such alignment reflects both their efficient attentiveness to and understanding of on-going interaction and activities.

Hence, it may be argued that in the observed CLIL science classroom ‘*silent*’ students skilfully revealed their developing *interactional competence in the target language* when they closely *monitored* classroom interaction unfolded (mainly) in this language and context-specific patterns that rule its sequential organization. As well as when they multimodally *displayed their moment-by-moment understandings* of such patterns. ‘Silent’ students also efficiently deployed their interactional competence when they *displayed their knowledge* of social and interactional practices typical of CLIL settings. And finally, when they precisely *coordinated and related their actions to those of other participants* in classroom interaction. It may be assumed therefore that by gradually acquiring new forms of displaying their participation in social activities of the CLIL science classroom CoP, such students simultaneously develop their IC in the target language.

Summing up, the analysis and the discussion of the preliminary results presented in this chapter have attempted to contribute to a better understanding of what it means to participate in the CLIL science classroom as well as to portraying a more subtle but more precise picture of CLIL students’ interactional competence in the L2. For this non-verbal and sequential aspects of social action have been brought in when looking at the CLIL classroom interactional practices.

CHAPTER 7: DISCUSSION AND CONCLUSIONS

7.1. CHAPTER OVERVIEW

As stated in chapter 1, the aim of this study has been to further understanding of the process of the interactional co-construction of dialogic explanations within a particular setting of one CLIL science classroom in English as the L2. With this aim, a fine-grained analysis of the following aspects that constitute the phenomenon has been carried out:

- a) The participants' use of **multimodal resources**, that is, material objects, gestures and talk in order to mediate the joint building of dialogic explanations,
- b) The participants' cooperative tackling of L2 **opacity** and content **density** that emerge in the process of elaborating such explanations,
- c) **'Silent'** students' displays of **participation** in the process of co-constructing dialogic explanations, and
- d) Teacher's **classroom interactional competence** and **scaffolding** procedures in guiding students in this process.

This concluding chapter starts with a final discussion of the main findings on each of these aspects emerged from the data exploration. It continues by providing a series of implications for teaching and teacher education. Finally, it presents some suggestions for further research.

7.2. MAIN FINDINGS

7.2.1. *On the multimodal mediating process of the co-construction of dialogic explanations in CLIL science classroom CoP*

Analytical chapter 4 has explored meaning making resources that the teacher and the students in the observed CLIL science classroom mobilized in order to mediate their joint enterprise of teaching-and-learning school-science in the target language. More particularly, the analysis has focused on the participants' co-construction of dialogic explanations, one of numerous social practices within their CLIL science classroom community of practice.

In the data exploration, the application of the machinery offered to researcher by CA and the multimodal approach to social interaction has rendered crucial. The detailed analysis has revealed that the languages available to the participants, paralinguistic elements and pauses as well as their gazes, gestures, head movements and material artefacts present in the classroom served them as *powerful interactional mediating tools*. The teacher and the students used them to establish a mutual interactional focus within their on-going activities and accomplish their highly contextualized and socially situated practices. In this way, they negotiated meanings, developed shared understandings of observed natural phenomena and jointly constructed accountable school-science dialogic explanations of such observations.

Thus, the participants have been seen to employ an array of subtle multimodal resources (e.g., pause, gaze, pointing gesture) to *demonstrate their understanding* of the verbal and non-verbal actions of other interactants as well as to *demonstrate new knowledge* they acquired in social interaction. They also meaningfully *incorporated* material artefacts such as microscopes and reference books into interaction, thereby making these objects relevant for the on-going co-construction of shared understandings and dialogic explanations. The students have been seen to competently combine non-verbal devices with the linguistic resources available to them, including code-switching and a creative use of the

target language, in order to state problems and knowledge claims, report their findings and use artefacts to support what they were claiming or reporting.

It has also been observed that the teacher sequentially and multimodally *guided* students in discovering school-science knowledge behind their empirical observations and *built* on the students' use of languages, gestures and objects, incorporating them into interaction as part of the co-constructed explanations. She also acknowledged and *officialised* the students' claims and reports by transforming their everyday wordings into appropriate school-science statements. She also introduced the students into accountable discursive practices of school-science (i.e., generating appropriate comparisons, descriptions or more abstract and general meanings).

So, the teacher and the students employed material and semiotic tools to mediate their situated actions, sequentially organize them and collaboratively accomplish the interactional activity of co-constructing dialogic explanations. It may hence be suggested that the way they did it evidenced their joint orientation towards the teaching-and-learning process as 'apprenticeships to new discourses and knowing as abilities to use-in-practice' (Hawking, 2004: 89). It also evidenced their orientation towards the students' progress in talking school-science accountably and in the target language. Finally, it also evidenced their orientation towards the students' gradual transformation into competent practitioners of their school-science classroom CoP.

Such orientation has also been observed in a recurrent *interactional pattern*, identified in all three interactional projects analyzed in chapter 4. Namely, that it was the teacher who always initiated the sequence of the negotiation of meaning which triggered the subsequent joint construction of a dialogic explanation, yet that it were the students who initiated the very interactional project by soliciting the teacher's expertise or reporting their empirical findings. It has therefore been argued that the resulting dialogic explanations were teacher-led but student-initiated.

7.2.2. *On the participants' cooperative tackling of opacity and density*

The sequential and multimodal micro-analysis accomplished in chapter 5 has shed light on the way the participants signalled and tackled cooperatively linguistic and conceptual obstacles caused by the opacity of the target language and the density of subject-matter content in this CLIL science classroom. The teacher and the students have been seen to follow a *primarily verbal, interactional and problematic path* in dealing with the emerged obstacles.

In the first place, it has been observed that the extended teacher-led dialogic explanation emerged as *a consequence of the difficulty two students faced* in unveiling the linguistic opacity and/or content density of one lexical item. It should be noted that a few seconds before the item had been overtly de-contextualized and remediated by the teacher through the provision of translation to the L1 and an antonym in the target language. Yet, a private interaction between these two students has uncovered that in fact the concept still remained both opaque and dense for (at least) these two students. This resulted in their decision to resort the problem to the teacher through the explicit (and interactional) signalling of the obstacle to comprehension.

In the process of tackling the obstacle and in order to guarantee the students' understanding, the teacher both richly mediated and remediated the problematic concept, mainly relying on verbal and prosodic means. Thus, she mobilized different target morpho-syntactic structures and lexical devices (e.g., antonyms, synonyms) which helped her to construct a chain of negations and assertions and a complex common semantic network of interrelated subject-specific concepts, thereby contextualizing the concept and strengthening the line of argument she was developing. Additionally and on the contrary to the initial remediation sequence in which she has been seen to create a distance between her and the class through a 'you' perspective, this time the teacher often employed 'we'-statements and its derivatives through which she attempted to foster students' involvement and a greater sense of her and the students as a community.

Her combination of prosodic elements (e.g., intonation, emphasis, speed of speech delivery) with well-measured pauses and non-verbal actions (e.g., gaze, gesture, head and body movement) also contributed to the reinforcement of her verbal message. These resources allowed the teacher to mark key concepts and relevant pieces of knowledge throughout the explanation as well as to establish semantic relationships among them. In this way she provided additional scaffolding to the students in their understanding of both the concept under consideration and other opaque and dense L2 terms which she introduced for the (re)mediation of the latter. She also efficiently acknowledged a contribution made by one of the students by inserting it into the on-going explanation. In this way she also favoured students' participation in the joint construction of dialogic explanations.

Such discursive adjustments and multimodal actions accomplished by the teacher resulted in the elaboration of *a contextualized and effective student-friendly explanation* which afforded the class opportunities for the integrated appropriation of the target language and academic content.

The analysis has also provided insights into a classroom practice which some researchers (e.g., Dalton-Puffer, 2007) claim to be highly recurrent in CLIL settings, namely 'explanation by translation'. The teacher's *provision* of the L1 counterpart of the de-contextualized term, through which she seemed to deal with the comprehension obstacle as only a language problem, was a scaffolding strategy which seemingly resulted in no direct understanding of the term by the students. On the contrary, the same de-contextualized treatment of the problematic term by the teacher which occurred *after* an extended and cooperatively constructed dialogic explanation rendered the students' explicit understanding of the item in the L2 and most probably in the L1 as well. It may be assumed that this was mainly due to the contextualization, exemplification and relation of the item to other concepts.

These findings strongly suggest that CLIL science classrooms may become innovative teaching-and-learning environments in which the process of constructing science explanations is dialogic, *teacher-led and student-centred*. In

the data analyzed, this process often emerged as a consequence of the students' active demand for clarification. The findings also indicate that, on the one hand, such dialogic explanations can constitute a *central resource in the teaching-and-learning process* in which the sequences of *mediation and remediation are highly interwoven* and support one another. The presence of these sequences allows the teacher to enhance students' understanding of the content which has been *problematized by the students themselves* due to its conceptual density and/or linguistic opacity in the target language, and thus overcome both conceptual and linguistic obstacles.

On the other hand, such dialogic explanations can also represent a *teaching objective* since the students are expected to eventually learn how to construct their own accountable academic explanations according to the recognized discursive norms of school-science. And ultimately, the processes of the *de-contextualization and re-contextualization of the interactional focus* on lexical items turns out to be an effective pedagogical strategy for L2 teaching in the CLIL classroom as, for example, what emerges as a lexical problem signalled initially by the teacher is sorted out by means of a dialogic science explanation triggered by the students' signal of the problem.

7.2.3. On varied ways of participating in classroom interaction and interactional competence in the L2 of 'silent' students

The adopted analytical approach that combined situated practice and multimodal micro-CA has helped to shift the focus from communicative competence as an outcome of CLIL instruction to the kinds of communicative and interactional competences already displayed by the students in accomplishing actions relevant for learning. This approach has also contributed to further understanding of what it means to participate in the CLIL science classroom as well as to portray a more subtle but more precise picture of CLIL students' interactional competence in the L2.

The micro-analysis of embodied actions of the students in the observed classroom and particularly of those who remained silent throughout interactional

project 5 (chapter 6) has revealed the students' varied ways of participating in classroom interaction. The students have been seen to efficiently mobilize a range of multimodal resources in order to demonstrate their close attention to, understanding of, alignment with and availability to the current teaching-and-learning activity, all these being demonstrations of their developing interactional competence in the target language. 'Silent' students heavily relied on non-verbal devices such as gaze, gesture and head position in order to display their close attentiveness to on-going teacher-led activities as well as their orientation to the current speaker and relevant artefacts (e.g., handout, dossier, notes).

These analytical findings have confirmed earlier research on participation in classroom interaction (e.g., Bezemer, 2008; Duff, 2002; Koole, 2007; Sahlström, 2002) and contributed to its efforts to reconceptualize the traditional binary understanding of classroom participation as either 'active verbal' participation or 'passive silent' non-participation. Rather, it has been found that a variety of students' embodied actions displayed different degrees of participation in classroom interaction. More specifically, students' actions displayed varied involvement with the on-going interactional process of the co-construction of shared understandings and academic knowledge in the CLIL classroom.

This allowed suggesting that in accomplishing their sequentially appropriate situated embodied actions in the classroom, 'silent' students efficiently revealed their developing interactional competence in the target language. Namely, they portrayed themselves as interactionally competent by closely monitoring moment-by-moment progress of classroom interaction in this language. They also showed it through the precise coordination and tight relation of their actions to those of other participants in classroom interaction. As well as by non-verbally displaying their knowledge of social and interactional practices typical of CLIL settings. A final assumption has also been put forward that the gradual acquisition by 'silent' students of new ways of displaying their participation in social practices of the CLIL science classroom CoP might result in the concurrent development of their interactional competence in the L2.

Another outcome of this piece of research has been the elaboration of a tentative analytical framework for the identification and characterization of different participation patterns displayed by students in CLIL classrooms. A preliminary categorization of the phenomenon into four stages along the participation continuum has been advanced. It has been suggested that at stage 1 students already participate in classroom interaction by *silently but closely monitoring* the sequential organization of unfolding interaction.

Participating at stage 2 has been assumed to be evidenced in students' *precise aligning of their embodied actions* with those of other participants. Having successfully acquired these embodied displays of participation, students then move forward to stage 3 where they are able to display their *availability, that is, disposition, to contribute to classroom interaction* and the teaching-and-learning activity in progress. Finally, at stage 4, it has been suggested that by attempting to attract the teacher's attention, project their speakership and get the interactional floor both in embodied way and verbally students display their *willingness to speak*.

Hence, this categorization may help researchers to identify and describe where students are in their learning how to efficiently participate in CLIL classroom interaction and contribute to on-going teaching-and-learning activities.

7.2.4. *On the teacher's classroom interactional competence (CIC) and interactional scaffolding strategies*

The findings obtained in three analytical chapters and discussed in general terms in this concluding chapter (sections 7.2.1-7.2.3) have depicted a teacher who efficiently deployed CIC to *guide* the students in their cooperative enterprise of teaching-and-learning school-science in the target language within their classroom CoP. Namely, she used *learner-convergent language* and afforded the students necessary scaffolding in their joint discovery of the *scientific procedure of constructing explanations* and in the *students' learning of such school-science skill*. The obtained findings have also shown a teacher who foresaw possible lexical problems, which could have potentially hindered the students' understanding of

certain content terms and concepts due to their potential opacity in the L2, and therefore initiated a trouble-shooting remediation sequence.

Through the detailed analyses of interactional projects 1-5 it has been observed that the teacher was open and responsive to the students' questions and contributions. The emergence of student-initiated interactional sequences and their interactional treatment by the teacher through her discursive adjustments and the use of non-verbal resources may also be considered indicators of her effective enactment of CIC. Namely, they indicate that she succeeded in *affording students interactional space*, yet losing neither her initiative nor her guiding role in the elaboration of dialogic explanations.

Interactional space provided by the teacher resulted in a learning-fostering environment in which students were encouraged (and sometimes even required) to participate in the interactional co-construction of subject-specific knowledge. The students were also expected to acquire procedural and analytical academic competences – such as the elaboration of accountable school-science explanations – through the use of the target language (and other semiotic resources) in which they were apprentices as well as to develop their L2 lexical-discursive repertoire through the very act of participating in classroom interaction.

Finally, the teacher has also been observed to *shape the students' contributions* to unfolding interaction in order to promote the creation or consolidation of their linguistic-discursive repertoire in the target language. She repaired their utterances into appropriate L2 academic constructions and provided assessment on their interventions. She also legitimated and officialised the students' knowledge claims verbally by transforming their claims expressed in everyday language into knowledge-based, school-science statements in the academic L2.

Drawing on the obtained findings, the following list of interactional scaffolding procedures accomplished by the teacher in the observed CLIL science classroom has been arranged. However, it needs to be taken into account that this list is in no way exhaustive.

1. To shape discourse and students' interventions using learner-convergent language and guide students in the interactional co-construction of dialogic explanations:

1.1. Building linguistic bridges between acceptable school academic discourse and everyday discourse in the L2:

- Reformulating abstract terms into familiar ones,
- Reformulating everyday words into academic terms,
- Reformulating the same statements through negations and assertions,
- Providing etymological and colloquial definitions,
- Providing scientific and colloquial examples,
- Introducing everyday-life objects that constitute shared knowledge into interaction,
- Generating more abstract and general meanings by reformulating students' familiar and concrete examples or contributions,
- Providing more precise terms both in everyday and academic L2,
- Using everyday L2 in negotiating meanings and constructing shared understandings, yet relying on academic L2 in recaps,
- Gradually moving from students' empirical classroom experiences to the joint construction of general and abstract academic knowledge.

1.2. Adjusting and narrowing down questions.

1.3. Providing multimodal comparisons.

1.4. Providing concepts' translation to L1 after co-constructed dialogic explanations in which concepts have been contextualized, exemplified and related to other content terms.

1.5. Marking key concepts or important pieces of knowledge being provided:

- Prosodically (emphasis),
- With pauses after each concept,
- Non-verbally (rhythmic headshakes, nods, leaning forth towards students).

- 1.6. Creating semantic networks by establishing relations among concepts and employing synonyms and antonyms.
- 1.7. Reinforcing arguments being developed by combining deictics and (iconic and pointing) gestures.
- 1.8. Reinforcing verbal messages:
 - Prosodically (emphasis),
 - Non-verbally (nods and headshakes).
- 1.9. Relating verbal messages to material artefacts through deictics and pointing gestures.
- 1.10. Making reference to previous common experience when negotiating meanings with students.

2. *To facilitate interactional space to students:*

- 2.1. Creating a greater sense of personal involvement for students (statements containing first person plural pronouns).
- 2.2. Creating physical and emotional proximity to students.
- 2.3. Providing more freedom to self-select or remain silent by addressing the whole class.
- 2.4. Soliciting students' active co-participation in interaction:
 - Verbally (confirmation and clarification requests, designedly incomplete utterances),
 - Non-verbally (gestures, gazes and head movements).
- 2.5. Creating opportunities for students to ask their own questions.

It may be suggested that – to a high degree – the teacher's competent deployment of the above listed interactional scaffolding strategies, which

evidences her use of a wide range of multimodal mediating resources, fostered interaction in the target language in the observed CLIL classroom. This in turn created space and tools that resulted favourable both for the co-construction and problematization of academic (content and language) knowledge and for a more active participation of the students in this process.

The fine-grained analysis has provided new findings and insights into the way the teacher organized and managed the development of academic explanations in the classroom, thereby contributing to the growing research on interaction in CLIL settings (e.g., Escobar Urmeneta and Evnitskaya, 2011; Nikula, 2005; Simon Auerbach, forthcoming, 2012; Smit, 2010). These findings also largely support Evnitskaya and Morton's (2011) and Escobar Urmeneta and Evnitskaya's (2011) preliminary outcomes on the same data corpus. These two recent studies have shown this teacher to be a successful CLIL teacher who skilfully deployed scaffolding procedures in promoting classroom interaction and students' participation in the social interactional practices of meaning making and the construction of school-science knowledge in the target language.

7.3. GENERAL CONCLUSIONS AND IMPLICATIONS FOR TEACHING AND TEACHER EDUCATION

7.3.1. General conclusions

Within the limited scope of this study, it may be stated that the quality of dialogic explanations co-constructed interactionally in CLIL classrooms highly depends on the combination of three components. These are the efficient management of the patterns of mutual engagement, the multimodal meaning making resources and the teaching-and-learning goals shared by teachers and students (see also Evnitskaya and Morton, 2011; Moore and Dooly, 2010).

A further relation may be established between the quality of the co-constructed academic explanations and the treatment of *students' private turns* within teacher-led activities. Being usually negatively thought of and reprimanded or simply overlooked by teachers, such private turns may however become

interactional spaces for students' legitimate peripheral participation in classroom social practices. This study has shown that they may also eventually transform into explicitly and publicly stated students' questions, requests of clarification or repetition, demands for help or comments, thereby leading to their increased participation in classroom interaction.

The study has also demonstrated that the adopted analytical approach to CLIL data rendered very well suited to capturing and describing intricacies and specific features of the interactional process of co-constructing academic dialogic explanations in one CLIL science classroom. More particularly, it has been shown that the combination of different sociocultural constructs with the conversation analytical tools and the multimodal perspective on social interaction has afforded the study a rich and multi-level interpretative framework. This framework allowed the author to shed light on the interactional phenomenon under consideration by examining it sequentially and multimodally from different angles. The study has therefore provided further evidence that *Multimodal CA-for-CLIL* may enable researchers to further understanding of the way particular social classroom practices such as, for example, the construction of academic explanations, can be jointly and interactionally accomplished by participants in specific educational settings like CLIL.

7.3.2. Implications for teaching and teacher education

The kind of analysis presented in this study aspires to make CLIL teachers aware of the necessity to organize classroom interaction in such a way that all students, regardless of their proficiency in the target language, are given opportunities to participate in the interactional practices relevant for the teaching-and-learning of subject-matter content in the L2. To achieve this goal, CLIL teachers are to provide students with necessary interactional scaffolding which will help them understand, produce and negotiate academic messages in the target language adopted as the medium of instruction. Yet, success in this undertaking depends to a great degree on the quality of the interactions co-constructed between teachers and students and therefore on the teacher's classroom interactional competence.

CLIL teachers should also be encouraged to make numerous, rich and varied use of multimodal meaning making resources available to them in providing appropriate support to their students and guiding them in their learning process. Interactions that legitimize gazes, gestures and material objects, which are present in classroom and result significant for the on-going pedagogical activity, as resources for the negotiation of meanings and the construction of academic knowledge can support students in learning to talk disciplinary language suitably.

This study also highlights the necessity for CLIL teachers to enlarge their conception of students' participation in classroom interaction and of their language competence in the L2 and its development. Teachers are to be able to recognize and acknowledge resources that students use to demonstrate their understanding of academic messages produced by teachers and their peers as well as to make their own contributions to interaction. Yet, apart from recognizing and accepting these resources, CLIL teachers also need to create interactional situations that will give students opportunities to make use of multimodal resources.

As a consequence, there is the necessity for CLIL pre-service and in-service teacher education courses to pay more attention to furthering teachers' understanding of the role of language and other semiotic resources in scaffolding students' learning of both academic content and the target language through classroom interaction. Therefore, it is hoped that the study may contribute to help policy makers and course developers to make relevant decisions on these issues.

7.4. SUGGESTIONS FOR FURTHER RESEARCH

The fine-grained analysis of CLIL classroom data accomplished in this study has identified and characterized resources and competences deployed by participants in constructing dialogic explanations in CLIL settings. Yet, it also raised several issues which render importance for CLIL research and may turn to be promising objectives for future research.

The first issue is the way new academic knowledge is jointly generated and transformed in particular CLIL environment. In the study, the joint construction of knowledge within dialogic explanations has been treated from the perspective of mediated action and the community of practice approach to learning. Such analytical treatment has provided a series of rich descriptions and interpretations of the way participants multimodally mediated this interactional and social process within their CLIL classroom CoP and how such mediation contributed to the students' learning of school-science in the L2.

Yet, another prominent theoretical perspective, namely, epistemology, which over years has produced extensive research on the topic, may enrich the obtained findings and further the understanding of the phenomenon developed in this study. In this sense, deeper insights into the way academic knowledge is co-constructed in interaction may also be gained through the examination of students' notes. Their relevance for the participants' joint enterprise of co-constructing knowledge through explanations has been evidenced in this study in the fact that on certain occasions the students overtly oriented towards their notes in order to check something or jot down pieces of knowledge that have been provided through the dialogic explanation.

Another promising issue is students' explanations in the CLIL classroom. It represents an extremely understudied topic since little research on explanations in CLIL settings (section 2.7.2) mainly focuses on teacher's explanations. Yet, Kupetz (2011) closely looks at one student's explanation and shows how the activity of 'explaining' is sequentially organized and collaboratively accomplished by all participants. Considering that Kupetz's study and this dissertation differ in both content subject analyzed (geography and biology, respectively) and students' age (15 and 12, respectively), it may therefore result fruitful and contribute to the development of the topic to apply the insights on teacher-led dialogic explanations gained in the present study to students' explanations.

Finally, another research line initiated in this study urgently calls for further research. More particularly, it is the participation of 'silent' students in CLIL classroom interaction. A fine-grained analysis of their embodied actions has

revealed that in accomplishing such actions sequentially and coordinating them timely with those of other participants such students efficiently displayed their attentiveness and close monitoring of unfolding L2 interaction and, thereby, their interactional competence in the L2. Due to the limits of space and time, this study has only had a close look at one interactional project, which implies that the way how the students displayed their interactional competence has been observed at only one moment, that is, the moment of data collection.

Therefore, in order to be able to put forward any tentative assumptions about the progress of 'silent' students in the situated learning of the target language, a longitudinal tracking of their interactional development is in need. A micro-analytical examination of a series of interactional projects separated by a certain period of time may provide important insights into whether and how these students develop their interactional competence in the L2 and acquire more advanced – mainly verbal – forms of participation in classroom interaction, which in this study have been tentatively characterized as 'availability' to make a contribution and 'willingness to speak' (section 6.3). Such longitudinal examination of the data strongly suggests the maintenance of the analytical framework adopted in this study.

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APPENDICES

1. TRANSCRIPTION CONVENTIONS

For talk, Conversation Analysis transcription conventions proposed by Gail Jefferson (Jefferson, 2004):

JAU:	Initials followed by a colon correspond to the speaker's pseudonym.
(.)	A dot in parentheses indicates an unmeasured (micro-)pause of less than two-tenths of a second.
(1.5)	Numbers in parentheses indicate measured pauses in tenths of seconds.
=	An equal sign indicates 'latching' (no gap) between utterances produced by the same speaker or different speakers.
over[lap] [overlap]	Square brackets indicate start, and if relevant, end of concurrent speech.
<u>word</u>	Underlining indicates speaker's emphasis.
CAPITALS	Talk is louder than that surrounding it.
^o word ^o	Talk is quieter than that surrounding it.
wo(h)rd	(h) indicates 'laughter' within the word.
↑↓	Pointed arrows indicate a marked rise or fall in pitch, not necessarily a question or the end of the utterance.
.	Falling intonation.
,	Low-rising intonation, suggesting continuation.
?	Rising intonation, not necessarily a question.
	Vertical bar after each word indicates speaker's rhythmical emphasis.
cu-	A single dash indicates a sharp cut-off.
:	Colon indicates that the speaker stretched the preceding sound, more colons more stretching.
>fast< <slow>	'Greater than' and 'less than' signs indicate that the talk was produced noticeably quicker or slower than the surrounding talk.
xxx	'xxx' indicate an unclear fragment in the recording with one 'x' equal to one syllable.
(word)	Words in parentheses indicate best guess at an unclear fragment.
<i>word</i>	Bold italics indicate utterances produced in any other language that is not English.
[...]	Dots in square brackets indicate that some material has been left out.

For multimodality, Multimodal Analysis transcription conventions proposed by Mondada (2008), developed and adapted by Moore (2011) and Moore and Nussbaum (2011) and further adapted in this study:

Actions are described in the line following the line containing utterance, in italics, and are synchronized with talk thanks to a series of landmarks:

<i>jau</i>	Participant accomplishing the action is identified
* fig1.1-a	The instant when action starts or finishes/screen shot was taken within turn at talk
*----	Gesture or action described continues across subsequent lines
---->*	Gesture or action described ends when the symbol * is reached
<i>tea</i> *turns to ARN----->*	Example of multimodal transcription

2. TEACHING MATERIALS (DOSSIER)

Available in digital version only.

3. HANDOUT EXPERIMENT: EUGLENA

Available in digital version only.

4. TRUE-FALSE ACTIVITY

Available in digital version only.

5. HANDOUT HUMAN BODY

Available in digital version only.

6. VIDEO CLIPS

Video clips are identified according to Excerpt numberings in the text (e.g., clip 1.1 corresponds to Excerpt 1.1).

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