MASTER EN LINGÜÍSTICA INGLESA

DEPARTAMENTO DE FILOLOGÍA INGLESA I

UNIVERSIDAD COMPLUTENSE DE MADRID

# *Classroom Interaction in University Settings: The Case of Questions in Three Disciplines*

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DATE: September 12, 2010

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## SUMMARY IN SPANISH / RESUMEN EN ESPAÑOL

El proceso de internacionalización de la universidad que el Espacio Europeo de Educación Superior (EEES) ha iniciado, con la adopción de un sistema flexible y comparable de titulaciones, la implantación de un sistema de créditos común, y la movilidad del alumnado y profesorado, ha traído consigo también la utilización de la lengua inglesa como lengua franca de comunicación y de instrucción curricular. Así, numerosas universidades españolas, tanto públicas como privadas, ofrecen entre sus Grados y Postgrados Titulaciones Bilingües o Europeas donde la lengua de comunicación y evaluación es el inglés. A pesar de que estos programas gozan de enorme aceptación entre los alumnos, y la demanda a menudo excede la oferta actual, sobre todo en lo que se refiere a las universidades públicas lo cierto es que los aspectos lingüísticos y metodológicos relacionados con el Aprendizaje Integrado de Contenidos y Lengua Extranjera (AICLE) no han sido abordados de manera concreta y específica (Dafouz y Núñez 2009; Lasagabaster, 2008; Fortanet, 2008),

La implantación de la enseñanza AICLE en el espacio de Educación Superior en España se ha realizado hasta la fecha de forma muy heterogénea y descentralizada (Dafouz y Núñez 2009), y con escasas o ninguna adaptación curricular de los planes de estudios existentes (Dafouz, 2008; Dalton-Puffer y Smit 2007). Existe, por tanto, la imperiosa necesidad de llevar a cabo investigaciones empíricas rigurosas que pongan de relieve las necesidades lingüísticas y particularidades metodológicas derivadas de la implantación de este nuevo enfoque. La tesis aquí propuesta pretende así contribuir a la investigación en un ámbito que requiere de datos empíricos fiables para su consolidación como alternativa para el aprendizaje conjunto de una lengua extranjera y de contenidos curriculares específicos.

El denominador común de la instrucción a través de una lengua extranjera (normalmente el inglés) es que dicha lengua deja de ser el contenido de la instrucción y el sujeto de la misma, para convertirse en el vehículo por el que el aprendizaje toma forma. Como consecuencia, el discurso del aula, como medio de comunicación gana una tremenda e indiscutible importancia en el

marco de la educación, puesto que se convierte en el esqueleto de la transmisión de conocimiento y esta lengua franca pasa a ser utilizada por profesores y alumnos a menudo con lenguas maternas diferentes a la lengua inglesa.

Puesto que el objetivo primordial de cualquier clase es el aprendizaje, las pautas que se marcan para llegar a dicho aprendizaje también estructurarán y determinarán las formas de uso del lenguaje en un aula que se caracteriza por la interacción natural entre alumno-alumno y alumno-profesor. Dalton-Puffer (2007) hace referencia a dos teorías del aprendizaje que forman el eje principal de su estudio y serán trasladados al nuestro: (1) la teoría constructivista, que considera al aprendizaje un proceso activo mediante el cual los alumnos construyen nuevas ideas y conceptos en base al estado de su conocimiento actual. Por lo tanto, la meta del profesor es presentar el nuevo material de tal forma que enlace con el conocimiento previo del alumno para despertar en éste el interés hacia lo nuevo y desconocido (Bruner, 1966); (2) el aprendizaje participativo, por el que la adquisición de nuevos conocimientos se cimienta en la interacción social y ocurre como consecuencia de su práctica y desarrollo (Vygotsky, 1978).

La base teórica del presente estudio toma como referencia los estudios centrados en el discurso del aula y en concreto el análisis de los recursos empleados para incentivar la *interacción* en el aula. Así, las *preguntas* (Cazden, 1988; Chaudron, 1988; Hatch, 1992; Wells, 1996) serán analizadas para indagar sobre qué estrategias se emplean en las aulas integradas (AICLE) para incentivar la interacción y así el aprendizaje de la lengua extranjera y el contenido curricular.

Utilizando la tipología de Dalton-Puffer (2007: 95-100) para el análisis de las preguntas, la lingüista austriaca se aleja de las clasificaciones más tradicionales en las que se establecen oposiciones binarias tales como preguntas abiertas o cerradas, y da mayor importancia al propósito para el que sirven las preguntas presentando así las siguientes categorías: preguntas de hechos, de explicación, de razones, de opinión, y de cognición.

En base a esto, la presente tesis parte de la visión de que las estrategias de interacción, y en concreto las preguntas, que articulan el intercambio comunicativo entre los distintos participantes en el aula, desempeñan una función crucial en la construcción del conocimiento y en la organización de la lección. Las preguntas son herramientas lingüísticas que favorecen la interacción y facilitan la comprensión de contenidos, además de prevenir vacíos interpretativos en la comunicación.

Con el estudio que aquí se propone se pretende arrojar luz sobre los procesos de enseñanza-aprendizaje en lengua inglesa como lengua de instrucción en la educación superior. Como se ha indicado anteriormente, la puesta en práctica de este tipo de docencia (aunque cada vez más extendida) no ha recibido la atención lingüística o metodológica necesaria para una efectiva implantación. Se pretende, por tanto, describir la situación docente en lo que se refiere al discurso en el aula y proporcionar pautas metodológicas concretas para fomentar la interacción en el aula, en concreto en lo que se refiere al uso de preguntas de diverso tipo. En línea con teorías interaccionistas de aprendizaje (Vygostky, 1978; Block 2003) la interacción fomenta el aprendizaje de contenidos curriculares así como el aprendizaje de la lengua extranjera (Long, 1996). Utilizando un corpus interdisciplinar en lengua inglesa recabado mediante el corpus de un grupo de investigación UCM [1] y el corpus online MICASE, se pretende analizar las estrategias más eficaces para favorecer la interacción en el aula, con el fin de ayudar al docente no-nativo en la enseñanza de contenidos en la lengua extranjera.

[1] (REF: GR60/09) Enseñanza Integrada de contenidos y lengua extranjera en la Educación Superior (EICES).

ABSTRACT

The paper will report on the analysis of the natural interaction between teacher-student and among peers in a Spanish university context where teaching is conducted through the English language (CLIL). The theoretical framework of this study takes into account previous research (Cazden, 1988; Chaudron, 1988; Hatch, 1992; Wells, 1996) shedding some light on classroom discourse and more specifically on the different resources employed to foster interaction in the learning context. The linguistic phenomena that articulate the communicative exchange build on the construction of knowledge and the organization of the lecture. As the socio-cultural and constructivist approaches (Vygotsky, 1989; Piaget, 1970; Long, 1985; Krashen, 1985) to language proposed, learning is not only an individual mental process, but also a social event. Thus, students learn through participation in social situations and contexts, which materialize in the classrooms. This empirical study examines the discourse of three lectures accounting for eight hours and 45 minutes of teaching practice within the realm of Business, Engineering and Physics at the tertiary level using corpus methodology. The creation of the aforementioned corpus consisted of the recording and transcription of the sessions to be examined. The preliminary results show that interpersonal discursive aspects (Halliday, 2004) come into play in terms of questions (Dalton-Puffer, 2007) as key strategies occurring in the CLIL approach to promote interaction and, consequently, the development of both the foreign language and the content subject. The findings can be implemented towards describing the current instructional practices at university as regards classroom discourse and providing strategies that promote interaction in class and facilitate the delivery of content on the part of the teacher as well as the improvement of linguistic and academic competence on the part of the student.

KEYWORDS: Bilingual Education/CLIL, interactional strategies, communicative exchanges, questions, tertiary / university learning context.

# 1. INTRODUCTION

Over the last two decades, a new educational approach which promotes the teaching of disciplinary content through a foreign language, the so-called Content and Language Integrated Learning (CLIL), has been proposed and developed all around Europe. Even though education through a language other than the mother tongue dates back to the Greeks, CLIL is a recent phenomenon in Europe and the result of current world demands. Some of the main driving forces leading to the implementation of CLIL are globalization and also the fast-growing presence of English in everyday life; thus, becoming a lingua franca since it is the language of business, trade and instruction in countries where English is not the L1 nor an official language.

Likewise, European institutions encourage and prioritize plurilingualism in all its country members. In fact, citizens´ capacity of using more than one language in their daily communication is embedded in the core of European policies as a fundamental pillar in the construction of a socially and culturally unified Europe.

Although CLIL presents similarities with other approaches that also foster bilingualism (content-based instruction, task-based instruction or English as an additional language), it advocates for the equal status and importance of language and content. Therefore, CLIL supports content and language evenhanded integration as opposed to the aforementioned approaches, which tend to give more weight to one aspect over the other. In Crandall´s (1994: 256) words as quoted by Coyle et al. (2010: 41),

> Students cannot develop academic knowledge and skills without access to the language in which that knowledge is embedded, discussed, constructed, or evaluated. Nor can they acquire academic language skills in a context devoid of [academic] content.

As a consequence, teachers´ mission is twofold: they should offer collaborative and scaffolded meaning-making as regards academic content through negotiation of meaning as well as provide students with opportunities to

involve in multi-functional extended discourse and support them with feedback (Lyster, 2007).

### 1.1. Rationale for the current study

As it has been advocated by socio-cultural theories (Vygotsky, 1978, 1989; Bruner, 1983, 1985), learning is a cultural, social and constructive process which is accomplished through interaction. It is by means of purposeful communicative exchanges between teacher and learner and among peers that meanings are co-constructed, shared and better understood. As a result, classrooms could be referred to as social events in which not only academic content and language competence are achieved, but also learning and cognitive skills are maximized. In this line, teachers should be aware of the powerful tool offered by language in the form of meaningful interaction and should try hard to carry out efficient teaching practices which lead to the progression of learners´ content and language skills and knowledge, and to the development of higher-order cognitive processing and an intercultural awareness.

Winds of change are blowing through educational settings and are thus noticeable at tertiary levels, where traditional teacher-centered classrooms are becoming much more dynamic and interactive, giving the students an active role in their own learning and seeing the teacher as a facilitator or mediator instead of the one and only source of knowledge. As pointed out by Walqui (2006), “adolescent students learning academic subject matter in a new language face a number of challenges, both local and global in nature, as they negotiate the linguistic, academic and social world of schooling”. Despite all the potential obstacles coming into existence when studying through a language other than their mother tongue, the linguistic, educational, pedagogical and social benefits that learners are bestowed with (see Pérez-Vidal, 2009) for embarking on such an enterprise and also the help received by their teachers make the experience worth living.

Even though pair and group work are usually the most exploited activities because of their interactional nature, teachers can foster learning opportunities

through a large array of strategies such as asking questions to students, negotiating meanings, scaffolding techniques and so on. On the one hand, scaffolding aims at supporting and also helping the students through their learning process, for instance, in the accomplishment of a task which they would have not been able to manage on their own. As Gibbons (2002: 10) defines Vygotsky´s concept of scaffolding, it is "the temporary assistance by which a teacher helps a learner know how to do something, so that the learner will later be able to complete a similar task alone". On the other hand, negotiation of meaning targets the overcoming of potential breakdowns or misunderstandings through the modification or restructuring of the message addressed to the students. As claimed by Lyster (2007: 90),

> teachers need to exercise their responsibility as mentors interacting with novices by providing scaffolding that necessitates a variety of questioning techniques ranging from display to referential questions.

Following this line of argumentation, questions seem to be a prime strategy to foster natural interaction in the classroom and enhance students´ participation, especially when "student´s questions together with their responses to teacher questions actually form students´ oral output in CLIL lessons" (Dalton-Puffer, 2007: 112). Besides, classroom exchanges between participants seem to be articulated by questions; therefore, these interactional tools deserve an in-depth analysis in order to describe the current instructional practices at university as regards classroom discourse and to provide strategies that facilitate teachers´ delivery of subject matter and students´ academic and linguistic competence.

### 1.1.1. Aim and research questions

Some research has been carried out on discursive and interactional aspects in the teaching practice (Crawford Camiciottoli, 2004; Fortanet, 2004; Morell, 2004), but not much of it has been devoted to the specific role played by questions in CLIL classrooms at tertiary level. Consequently, this paper tackles this question by providing an account of questions as strategies to promote

interaction and provide students with opportunities to engage in extended discourse. This study aims at answering the following research questions:

1. What kind of questions do *teachers* use as interactional strategies in university lectures?
2. What kind of questions do *students* use as interactional strategies in university lectures?
3. Do the types of questions formulated by *teachers* vary in L1 and EFL contexts?
4. Do the types of questions formulated by *students* vary in L1 and EFL contexts?
5. Do the types of questions vary across different disciplines, and specifically, in the three disciplines compared in our corpus, namely Business, Physics and Engineering?
6. Do all types of questions trigger interactional practices?

## 1.2. Organization

This present study is structured as follows: first, a theoretical framework will make reference to some of the most important notions and published works related to the field of interactional theories of learning and theories of second language acquisition. Second, a methodology section will provide a description of the procedural steps and the materials used in order to carry out the present study. Third, the results obtained from the analysis of questions in classroom discourse will be shown alongside their discussion. And finally, the remainder of this study will present a conclusion, the references used and an appendix showing some examples of the analysis.

## 2. THEORETICAL FRAMEWORK

### 2.1. Learning from a socio-cultural perspective

According to socio-cultural theories, learning is a social process and it is precisely through the interaction between child and parents and child, peers and teachers that learning is thus co-constructed.

Opposing Piaget (1926) and other theoreticians (Thorndike, 1914; Koffka, 1928) in psychology and education, Vygotsky (1978, 1989) believes that development and learning are not concurrent processes; rather the former lags behind the latter. The Russian psychologist makes a clear distinction between a child´s actual developmental level and what he coined as Zone of Proximal Development (ZPD). In this sense, he affirms that learning and development somehow match. Thus while the actual developmental level refers to those tasks that the child masters independently, and are already complete and mature skills, the ZPD (in Vygotsky´s (1978: 86) own words),

> is 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.

As a consequence, the child´s ZPD defines those functions which have not yet matured and which are in a state of formation by means of the collaboration and assistance of other peers or more expert individuals.

Many of the theories of second language acquisition use main sociocultural premises as their cornerstones. Following Vygotsky´s theory (1978) of learning and development as explained above, working in the ZPD involves assisting the learner in achieving tasks that he could not be able to attain on his own. Therefore, from this standpoint, such processes as scaffolding and negotiation of meaning are closely linked to the ZPD and help in the child´s developmental and learning processes.

Furthermore, the input and interaction approach also draws on socio-cultural ideas in that it focuses on the relationship established between

communication, acquisition and the various mechanisms that mediate between them. According to this theory, the input received, the output produced and the interaction triggering both of them as the result of negotiations of meaning are fundamental requisites to language acquisition.

A more thorough account of all the above said aspects in turn is offered next.

## 2.2. Input notions

The function of input has been treated differently throughout the history of language learning. Within behaviourist approaches (Bloomfield, 1933), language acquisition relied heavily on imitation. The child only learnt the language by means of the input that he received and which he would try to imitate. Therefore, language was seen as a stimulus-response event which was based on habits of speech on the part of the learner.

This conceptualization of how input affects language acquisition and how it interacts with the cognitive skills of the language learners has changed notably over time. Despite the fact that most approaches regard input as a very important aspect in language learning, while for the input-interaction theory and for information processing input does not need to be of a specific type, it should meet certain conditions for the input hypothesis (Krashen, 1985). Krashen (1985) considered that the input provided to learners should be ahead of their language competence in such a way that it is not over-familiar to students nor far too advanced in level so that it remains inaccessible.

Later studies on input (Ferguson, 1975; Pine, 1994) took baby and foreign talk as data and reported on the similarities of these speech systems. One of the main conclusions drawn is that there are similar linguistic modifications occurring when adults address children and when native or proficient speakers address non-native or non-proficient speakers. Some of these modifications affect the speech, which tends to be slower and louder, intonation, which is exaggerated, syntax, which becomes simpler, and

vocabulary, which is reduced to the use of basic level words. The adjustments that take place in such situations can be extrapolated to classrooms, as revealed by a study devoted to delve into the attitudes of teachers and students of tertiary education towards the potential implementation of CLIL in Spain (Dafouz et al., 2007). The paramount methodological alterations as undertaken by teachers involve the slowing down of the pace, the adaptation of the materials used and the reduction of content along with more repetition of ideas and a slower rate of speech. Modifications serve the function of ensuring comprehension and easing learning on the part of the students.

In addition, first languages are acquired in natural situations in which communicative exchanges questing for goods and services or information (Halliday, 1985: 68-69) make language authentic and meaningful. It is thus believed that "language is acquired most effectively when it is learned for communication in meaningful and significant social situations" (Genesse, 1994: 3). Therefore, a great effort is made in order to provide the L2 student with authentic, meaningful and comprehensible language so that he moves from input to intake and to output.

### 2.3. Output notions

Along with the exposure to considerable amounts of high-quality L2 input, the production of output in the L2 to a sufficient extent is required for successful L2 language learning. It has been observed that L2 learners do not reach native-like linguistic competence despite the great amounts of input received (Swain, 1985; Cummins, 1981). This fact leads to hypothesize that teachers give students very few chances to engage in extended discourse. Therefore, they do not get initiated in the use and production of language. These findings are in line with some of the conclusions recounted in Canadian immersion research (Stevens, 1976; Lengyel and Genesse, 1975), which claims that the receptive skills (i.e. reading and listening) are the ones benefitting the most in L2 learning contexts, whereas productive skills (i.e. speaking and writing) do not improve at the same rate.

The importance of output lies on the fact that it "stimulate(s) learners to move from the semantic, open-ended nondeterministic, strategic processing prevalent in comprehension to the complete grammatical processing needed for accurate production" (Swain, 1995: 128). As a consequence, there is a shift from the semantic use of language employed by the learner when processing input to a more syntactic use that the learner needs to impose to his utterances in actual language production.

Research on second language acquisition has also shed much light on other functions of output: (i) automaticity (Swain, 1995; McLaughlin, 1987) and (ii) hypothesis testing (Gass, 1997; Gass, 2003; Mackey et al., 2000). The former refers to the fact that it is the production of output to a large extent that helps L2 learners improve their linguistic skills and progress from the more arduous on-line creation of utterances to the correct accuracy and fluency of an advanced student by which language use becomes routinized and automatized. The latter involves the fact that if learners want to test their hypotheses and get a confirmation on whether their grammatical use of language is correct or incorrect, they may ask a direct question on form or produce utterances expecting to receive some feedback from the interlocutor.

### 2.4. IRF exchanges and lecture structuring

As far as teaching exchange is concerned, it was Sinclair and Coulthard (1975) that presented a descriptive account of classroom interactional discourse. Since its inception, this model has generated a large number of revisions and reconstructions (Coulthard and Montgomery, 1981; Sinclair and Coulthard, 1992). It is based on the fact that language in the classroom is highly structured and, consequently, can be classified into a rank scale; that is, there are different ranks which have a structure that can be expressed in terms of the units below it. The discourse analysis scale, as proposed by Sinclair and Coulthard, consists of 5 ranks around which the classroom interaction evolves: *lesson, transaction, exchange, move* and *act*. Thus, a lesson is a series of transactions, a transaction is a series of exchanges, an exchange is a series of moves, and a move consists of units of acts. The wider interest has focused on the level of

exchange, which encompasses a *boundary exchange.* It is typically uttered at the beginning or end of a lesson and involves two parts: one that is the frame or focus move (well, good, okay) and another one that follows and which comprises utterances with diverse purposes (that of directing, informing, stating, questioning). In addition, a three-move structure was suggested as regards exchanges, the so-called IRF exchange. It consists of an initiation (also known as the opening move in Sinclair and Coulthard´s first model and usually uttered by the teacher), a response (an answering or acknowledge move by the student) and a follow-up (normally teacher´s feedback). This IRF sequence has been strongly criticized for enhancing teacher-led lessons; however, there are not only detractors. In an opposing vein, it is also thought that IRF moves help to monitor students´ understanding and to guide students´ learning process. For example, Nassaji and Wells (2000: 378) maintain that "it is necessary for somebody to ensure that the discussion proceeds in an orderly manner and that, as far as possible, all participants contribute to, and benefit from the co-construction of knowledge".

As Gibbons (2002) argues, there have been two major educational ideologies of instruction. On the one hand, education has been considered a "transmission and reception of knowledge"; on the other hand, it has been considered a "progressive" pedagogy. While the first model conceives education as a process of transmission and reception, i.e., the student is an empty vessel that will be filled up with the teacher´s knowledge, and the language is not paid attention to as the vehicle of content whatsoever; the second one takes underlying cognitive structures into account when dealing with language abilities and it is talk that reflects what learners think about; thus, language is not perceived as a conduit in learning. Both models have been challenged on the grounds that they may equally present an individualistic view of learning and would not bring together its cooperative nature. As a result, Gibbons (2002) proposes an alternative orientation in which the roles of teacher and student are intertwined and both play active roles in the educational process. This may show the necessity to advocate the implementation of interaction through joint activities and a conscious awareness of the nature of the talk in which students are engaged in the classrooms. In Hammond and

Gibbons´ (2001: 25) words, “the kinds of talk that occur in the classroom are critical in the development of how students `learn to learn´ through the language, and ultimately how they learn to think”.

Despite all the shortcomings that may be found in the IRF sequence, it is also worth of consideration that this interactional pattern could be further exploited in aid of learners. Nassaji and Wells (2000) put forward three different roles that the teacher could take over in every sequence. First, the teacher could be the “primary knower” and consequently, students would become “secondary knowers”. Second, the teacher could work as “manager”, choosing the speakers, distributing turns and handing over the floor to different participants. And third, the teacher has the power to decide whether he/she would be the initiator of the sequence, or if a student should assume that role. This is important because it shows that the IRF sequence could offer some flexibility to teacher-student interaction. Besides, there is still the follow-up step to consider, which is usually employed as scaffolding.

Lecture structuring and delivery is a key interactional device since it has to do with the organization and the guidance of the audience through the unfolding discourse. Hence, there are interpersonal factors rising from the discursive aspects of lectures that establish a relationship between lecturer and students. Goffman (1981) suggested a classification of lectures distinguishing three different styles: a reading style, whereby the content is either read or delivered as if it were read; a conversational style, whereby notes are typically used as prompts and there is a tendency to interact with students, and finally, a rhetorical style, in which digressions, asides and jokes are pervasive.

In terms of lecture structural patterns, Cook (1975) identified a macro-structure and a micro-structure. The former consists of various `expositions´, which, concurrently, are made of a number of episodes: an episode of expectation (of optional character), a focal episode (which is compulsory), a developmental episode (which is obligatory) and a closing episode (which is compulsory). The micro-structure following Cook (1975) is described in terms of `moves´.

In turn, Young (1994) traces a similar picture by proposing three metadiscoursal phases: a discourse structuring phase, in which the speaker signals the direction that he will take in the lecture; a conclusion, in which the main points of the discourse are summarized; and an evaluation, in which "the lecturer reinforces each of the other strands by evaluating information which is about to be, or has already been transmitted" (Young, 1994). Although these phases are common to the majority of genres in academic discourse, Young (1994: 167) goes further by establishing three other phases that are characteristic of university lectures: interaction, whereby an exchange of ideas or information occurs between the lecturers and the audience; theory or content, whereby the main theoretical content is transmitted by the lecturer; examples, whereby the lecturer illustrates his point or the theory just explained.

### 2.5. Lecture interaction

Since the main objective of any instruction is learning, the steps that need to be followed to achieve new knowledge will also determine the actual use of language in the classroom, which is characterized by the natural interaction between teacher-student and among students. As Long (1996) claimed in his interaction hypothesis, interaction fosters the development of a second language because a primary source of positive and negative data is offered to students when interacting with a more competent speaker. As Netten (1991: 303) also claimed, the language exchange between teacher and student and among peers "may permit more experimentation with the language, leading to higher levels of competence in the second language".

As a result, even though the lecture still "remains the central institutional activity" (Flowerdew, 1994) and, in the majority of the cases, instruction at the tertiary level takes place in teacher-centered classrooms, the active involvement of students is gaining more importance and many efforts to succeed in that respect are made by employing different teaching strategies such as pair or group work. In fact, a study on CLIL university lectures (Dafouz et al., 2007) that tried to identify the most significant linguistic expressions used by non-native lecturers in university discourse found out that there is a tendency towards a

more egalitarian atmosphere at university. This balance in the role of instructor and students appeared to be reflected by the extensive use of the pronoun *we*, the avoidance of modal forms conveying obligation as well as the on-going involvement of students in problem-solving and reasoning tasks. However, these observations could also be proof of an over-mindfulness of content verbalization on the part of the teachers, who are by no means language experts. In any case, it could be affirmed that "the new teaching situation that CLIL is creating may act as a catalyst to balance the highly asymmetrical roles performed by instructors and students in some conservative university communities" (Dafouz et al., 2007).

Lecture discourse has always been regarded as a genre with an indisputable importance as it is the skeleton in the transmission of knowledge and the negotiation of meaning. It is worth noting that lectures are especially designed for audiences; thus, presenting an apparently interactional nature. In addition, lectures may not only be regarded as spoken texts, but as social events where participation and comprehension can be facilitated by the teacher in charge (Morell, 2004).

The interactional and interpersonal nature of lectures has inspired a rich line of research. For instance, Morell (2004) analyzed the interpersonal features of university discourses in an attempt to find out which linguistic aspects could make possible the transformation of non-interactive discourse into a much more interactive one in the hope to increase the chances of students to put into practice their linguistic knowledge. The results showed that personal pronouns, discourse markers, questions and negotiation of meaning strategies vary notably when interactive and non-interactive lecturers are compared. Therefore, by making use of interactive strategies teachers can enhance students´ participation in class, increasing their language proficiency. Evidence from this research also concluded that those teachers that promote their students´ critical and cognitive skills will tend to use interactive discourse features.

Another study revealed that interactive discourse could also be used to ease non-native audience´s comprehension of lectures. Crawford Camiciottoli (2004) examined the structure of interactive discourses as deployed by L1 and

L2 classroom lecturers. Her concluding remarks disclosed that interactive discourse structuring was not more frequent in L2 guest lecturers than in L1 native lecturers, as it was expected. However, it could be deduced that L2 speakers employ structuring devices to guide L2 listeners but, strikingly enough, also to aid their own language needs.

### 2.6. Scaffolding

The concept of scaffolding was originated in Jerome Bruner´s (1983: 60) work, who defined it as

> a process of `setting up´ the situation to make the child´s entry easy and successful and then gradually pulling back and handing the role to the child as he becomes skilled enough to manage it.

In other words, scaffolding refers to the temporary supportive structure and collaborative work undertaken to assist the learner until he becomes self-directed. In the triadic dialogue, the follow-up move is precisely a scaffolding instance since it is typically used by the teacher to evaluate the student´s contribution and confirm if the answer is correct or incorrect. However, this last turn in the IRF sequence can also maximize students´ output opportunities. If in addition to acknowledging the learner´s participation, the instructor invites the student to extend his initial idea, asks him a question that leads the learner to go further with his comment or elicits extra information that challenges the student´s cognitive skills, the learning process will be enriched and interaction will be fostered.

Following a similar line of research, Walqui (2006) goes further noting that a distinction should be pointed out between what she calls *scaffolding interaction* and IRF. The former refers to the speech exchanges that assist student learning by taken further students´ utterances; the latter involves a “recitation script” of the IRF type, which according to Tharp and Gallimore (1988) only consists of teachers´ lecturing and monitoring learners understanding by formulating simple questions. Therefore, instead of considering that the IRF can be adapted to create dynamic classrooms, some

scholars (Tharp and Gallimore, 1988; Wells, 1999; Walqui, 2006) establish a clear difference between scaffolding talk and the triadic conversation and still see the IRF sequence as a very limited discourse structure which does not allow for teacher-student or peer-to-peer interaction.

In any case, the scaffolding provided by an expert is not the only way to offer this kind of learner assistance. Another possibility includes the so-called *collective scaffolding* in which students help each other, especially in pair or group tasks. Furthermore, Van Lier (1996) suggests two extra situations for scaffolded learning: mixtability groups in which a student can assist other lower-level peers and working alone by drawing on one´s own resources and prior knowledge.

All the aforementioned scaffolding types occur through social interaction and are closely linked to Vygotsky´s (1978) Zone of Proximal Development (ZPD); thus, as Walqui (2006) mentions,

> amplifying and enriching the linguistic and extralinguistic context, so that students do not get just one opportunity to come to terms with the concepts involved, but in fact may construct their understanding on the basis of multiple clues and perspectives encountered in a variety of class activities.

### 2.7. Negotiation of meaning

According to Pica´s (1994: 493) work, negotiation "contributes to conditions, processes, and outcomes of L2 learning by facilitating learners´ comprehension and structural segmentation of L2 input, access to lexical form and meaning, and production of modified output". It tends to come into existence whenever interlocutors (or, in our case, teacher and students) feel, foresee or undergo difficulties in message understanding. Long (1981) carried out a ground-breaking research by examining the structure of conversations between native speakers and also between native and non-native interlocutors. His study revealed that apart from native speaker modifications there was a special interactional structure taking place in which speakers checked for confirmation,

comprehension and clarification by means of questions. Those he called “strategies” and “tactics for discourse repair” (Long, 1983).

As the result of studying negotiations of meaning (Hatch, 1978; Long, 1983; Gass and Varonis,1985; Pica,1994) it could be affirmed that interaction allows the negotiation of meaning between the instructor and the learners, which has a twofold potential: it aids L2 comprehension and draws students´ attention to L2 form. There is the general claim that the internalization of L2 forms and structures encoding the language is the result of the comprehension of message meaning. Therefore, it is deemed important to avoid breakdowns and possible difficulties in communicative exchanges. Teachers not only could provide structural, lexical and syntactic modifications to the input delivered, but they could also enhance it by highlighting subtle features of the L2 making them more salient to the students and, consequently, assisting them in identifying and internalizing L2 forms (Pica, 1994).

However, there has always been a much debate, as currently happening with the CLIL approach, about whether special attention should be paid to form or just the incorporation of ample opportunities for the negotiation of meaning would be enough to achieve academic content and second language proficiency. In the same vein, there is much discussion about the importance of language and content (also within the CLIL approach) and whether they are inextricably linked or whether any of them should receive more emphasis. All the opinions on this regard can be summarized into two diverging views: one affirming that content development is the main focus, therefore leaving language development in the background (Genesee, 1994); the other one claiming that both language and content are important aspects of learning in an immersion context and should thus present and receive an equal status (Met, 1998; Allen et al., 1990; Lyster, 2007).

## 2.8. Questions as interactional devices

Questions seem to be key tools in the communicative exchanges that ensure a natural and equal interaction in the classroom. In McCormick and Donato´s (2000: 183) words, questions are a "fundamental discursive tool for engaging learners in instructional interactions, checking comprehension and building understanding of complex concepts".

Questions are one of the several mechanisms in spoken discourse that facilitates and eases comprehension. In fact, they are textual elements in that they organize lectures, but they are also interpersonal in nature as they show the desire for a joint discourse (Morell, 2004). Besides, questions are a direct access to knowledge since the main objective of asking a question is to obtain unknown information, which means that people are internally motivated when formulating them. It is believed that questions influence the quantity and quality of students´ output in fundamental ways. Consequently, teachers should be able to present questions as input within classroom discourse in such a way as to function as a stimulus towards engaging students in interaction.

There is a sizeable literature dealing with the role and nature of questions (Cazden, 1988; Chaudron, 1988, Tharp and Gallimore, 1988) that aims at gaining more insight about the way in which teachers use these interactional devices since, as stated by Crawford (2007: 105), "since antiquity teachers have used questions to define issues and problems, stimulate thought and contribute to developing inquiring minds". This phenomenon does not only take place in dialogic lectures, but also in monologic ones, where students do not provide responses either because they are not requested to or because teachers answer their questions themselves.

Thompson (1998: 141) classified questions as *audience-oriented* and *content-oriented*. While the former type calls for a response on the part of the participants and may encompass comprehension checks and procedural inquiries; the latter serve to bring up new information and subject matter topics.

The body of work by Dalton-Puffer (2007) lists two well-established classifications of *questions*, which are based on binary oppositions: (i) *display*

versus *referential questions* (Mehan, 1979) and (ii) *open* versus *closed questions* (Barnes, 1969). While the opposition established in the first pair of questions lies on whether the answer to the question is known by the questioner (display) or not (referential), the opposition in the second pair relates to the extension of the answer. If the answers are limited to a yes or no, the question is referred to as *closed*, whereas if space is allowed for a more extensive response the question is regarded as being *open*.

Similarly to closed inquiries, answers to display questions are typically reduced and include a very limited number of words. On the contrary, referential questions have usually been defined as triggers of more authentic, longer, more complex and more involved responses on the part of the students. As a result, they may foster students´ output and give them better opportunities for language production. Hence, a high number of referential questions is ideally expected in classrooms, although most studies (Long and Sato, 1983; Musumeci, 1996) reveal that teachers tend to use more display questions than referential ones.

The aforementioned typologies only make reference to those questions asked by teachers, since traditionally it is the lecturer who tends to ask more questions in the classroom, and turn out to be quite restrictive and difficult to categorize in practice. For this reason, Dalton-Puffer (2007: 98) goes a bit further by adding a new and more concrete typology regarding the goal of the questions; thus, distinguishing between questions for facts, questions for explanations, questions for reasons, questions for opinions and meta-cognitive questions.

Apart from eliciting information and promoting students´ participation and output, questions also serve to handle communication breakdowns and to monitor students´ understanding. The questioning moves fulfilling those purposes are comprehension checks, clarification requests and confirmation checks (Long and Sato, 1983: 176). As their labels indicate, they request message elucidation and verification, which lead to the language modifications that are required in the negotiations of meaning.

The following chapter presents the research methods and the typology used in the current study. Likewise, the phenomenon of questioning is taken up again in the results and discussion section, whereby the use and role of teacher and student-initiated questions will be explored across three different disciplines in both EFL and L1 lectures.

## 3. METHODOLOGY

### 3.1. Data Collection

In order to reach the objectives of this empirical study a corpus of six lectures was gathered. As a contrastive analysis is carried out, half of the corpus (three lectures) consists of lectures conducted in Spanish; the other half (three lectures) comprises lectures conducted in English. Consequently, the teacher and students involved in the Spanish courses are mostly native speakers of Spanish and English works as the foreign language (FL). In contrast, the participants attending the US lessons are mostly native speakers of English and therefore, English is their L1.

On the one hand, the US English lectures were collected from the Michigan Corpus of Spoken Academic English (hereinafter MICASE), which contains approximately 1.8 million words resulting from different speech events such as seminars, lectures, tutorials, study groups, etc. On the other hand, the Spanish part of the corpus was cortesy of the research group "Enseñanza Integrada de contenidos y lengua extranjera en Educación Superior" (EICES) from Universidad Complutense de Madrid[2]. Two of these Spanish lectures were personally transcribed by the author of this study using a videotape provided by the research group already mentioned, while in the case of the third lecture, the author was provided with the transcript.

The MICASE corpus is available on-line and all the speech events ready for use were recorded at the University of Michigan at Ann Arbor. Thus, while all the lectures encompassed in the US part of the corpus come from the same source, the Spanish collection of lectures present more varied origins since they were gathered from different universities in Madrid: Universidad Rey Juan Carlos, Universidad Carlos III and Universidad Politécnica de Madrid.

[2] (REF: GR60/09) Enseñanza Integrada de contenidos y lengua extranjera en la Educación Superior (EICES). This consolidated research group was founded in 2004 and has since been coordinated by Dr. Emma Dafouz Milne. It has worked under the CLIL approach distributing questionnaires, gathering data and analysing them to provide a quantitative and qualitative evaluation of the implementation of CLIL in tertiary contexts.

The entire corpus accounts for 8 hours and 45 minutes hours of teaching practice and a total of 64634 words within the realms of Business, Physics and Engineering at tertiary educational settings. Three different fields of study were chosen in the hope to offer an ample and extensive analysis which not only covered two distinct roles of the vehicular language, but also assorted academic contents and discipline variation. Obviously, a big effort has been made to find lectures as similar as possible regarding duration, word counts and especially topics within the various study fields. Hence, disparate lessons have been avoided since comparisons and contrasts could only be established among common features. All the details are shown in the table below.

| LECTURE | DURATION | WORD COUNT | NUMBER OF STUDENTS | LOCATION | SOURCE |
|---|---|---|---|---|---|
| Business EFL | 90 minutes | 11321 | Approx. 10 | Universidad Rey Juan Carlos | EICES - UCM corpus |
| Business L1 | 80 minutes | 11321 | 60 | University of Michigan | MICASE corpus |
| Engineering EFL | 57 minutes | 5438 | 26 | Universidad Politécnica de Madrid | EICES - UCM corpus |
| Engineering L1 | 81 minutes | 10096 | 15 | University of Michigan | MICASE corpus |
| Physics EFL | 93 minutes | 13450 | Approx. 11 | Universidad Carlos III | EICES - UCM corpus |
| Physics L1 | 105 minutes | 13008 | 6 | University of Michigan | MICASE corpus |
| **TOTAL** | 506 minutes | 64634 | | | |

Table 1. Corpus description

The most salient features of each lecture are stated below:

- The EFL business lecture deals with the globalization of a company and the internationalization of the firm as the main topic. It belongs to a graduate degree on business administration. The lecturer is Spanish and is a professor of content at university. English functions as the foreign language for both lecturer and students.
- The L1 business lecture deals with behavior theory, motivation in the workplace and, more specifically, with the external and internal sources of motivation at work. As its Spanish counterpart, it is a course within a graduate program on management, although in this case, English is the

L1 for all the participants in the classroom. The professor is also a content teacher at tertiary level.

- The main topic in the EFL engineering lecture is the displacement of engines. This course is part of a graduate degree on engineering. Both the professor and the students are users of English as a foreign language and, once again, the lecturer is an expert in content teaching.
- The L1 engineering lecture evolves around the derivation of the cycle time for unit load automated storage retrieval systems. It is part of an engineering graduate program conducted through the L1 of both professor and students. The lecturer is a specialist on content matter.
- The EFL physics lecture focuses on the behavior of mono- and poly-crystals in deformation and on strengthening mechanism for weak and strong obstacles. It is taught by a native professor of Spanish for which English is a foreign language and it is part of a graduate program on nuclear physics. Students attending this class are users of English as a foreign language as well, although not all of them have Spanish as the L1 since there are several students who are French[3]. The lecturer is a professor of content.
- The L1 physics lecture is about interaction of classical fields with atoms or molecules and the quantized nature of the field. It belongs to a graduate program on physics and it is conducted through students´ and professor´s mother tongue. The lecturer is an expert in content teaching.

The class sizes vary considerably from 6 students to 60, as it can be seen in Table 1 above.

### 3.2. Procedure

During the analysis of the aforementioned corpus, the following procedure was developed. First, the transcriptions of all the six lectures were either obtained from the on-line MICASE website and from the EICES-UCM corpus or were personally transcribed from videotapes provided by the EICES-UCM research

[3] There may be similar cases in the other lectures as well, where some students may speak English as a foreign language or L2, but their L1 is different from Spanish.

group. This was followed by the identification of all the instances of questions occurring in the transcripts. Second, a qualitative approach was accomplished, which resulted in the functional classification of the different types of questions. The classification of certain ambiguous questions was always based on their prototypical function. The taxonomy employed was originally based on Dalton-Puffer´s (2007), although new categories were added to present a more complete and exhaustive description of the data found. Yet, further changes were made after a pilot study which analyzed two business lectures was conducted. Because of the low frequencies of occurrence of some of the categories of questions, major changes resulted in the narrowing down of several question types that could be subsumed into others; thus reducing the initial taxonomy. Table 2 displays all the variants used until the final taxonomy followed in the present study was finally developed for our research purposes.

| **Taxonomy by Dalton-Puffer (2007)** | **Initial taxonomy by Sánchez García** | **Final taxonomy by Sánchez García** |
|---|---|---|
| Display questions | **As moves by teachers:** | **As moves by teachers:** |
| Referential questions | Display questions | Display questions |
| Closed questions | Referential questions | Referential questions |
| Open questions | Topicalizers | Rhetorical questions |
| Procedural questions | Rhetorical questions | Retrospective questions |
| Regulative questions | Retrospective questions | Self-answered questions |
| Questions for facts | Self-answered questions | Personal addresses |
| Questions for explanations | Personal addresses | **As moves by students:** |
| Questions for reasons | Elicitation questions | Questions seeking explanations |
| Questions for opinions | Discourse structural | Questions seeking confirmation |
| Meta-cognitive questions | **As moves by students:** | **As moves by both:** |
| Comprehension checks | Questions seeking explanations | Confirmation checks |
| Clarification requests | Questions seeking confirmation | Procedural questions |
| Confirmation checks | **As moves by both:** | Indirect questions |
| | Comprehension checks | Repetition questions |
| | Clarification requests | Language questions |
| | Confirmation checks | |
| | Procedural questions | |
| | Indirect questions | |
| | Repetition questions | |
| | Language questions | |

Table 2. Question Taxonomies

A definition of each of the question types analyzed in the present study is offered next:

- Display questions are those to which the answer is known by the speaker. Therefore, in classrooms teachers use them to find out the actual knowledge of students on a certain topic.
  E.g.: “which are the advantages of exporting?”

- Referential questions are those to which the answer is not known by the teacher. They are typically described as the more “natural” and “authentic” type of question.
  E.g.: “what sorts of ideas have you come up with?”

- Rhetorical questions are those to which no answer is expected. They are meant to make the audience think and reflect on something, but the actual solution (if there is one) is left up in the air.
  E.g.: “how can we face those industries?” (+ no answer follows)

- Self-answered questions are those which are immediately answered by the speaker himself, preventing other participants from providing any response.
  E.g.: “is it possible to be leading in one country and being completely inexistent in another? Yeah, it´s possible. It happens”

- Retrospective questions are those which make hearers go back in time to revise some issue.
  E.g.: “remember back to the uh, second class?”

- Personal addresses are those questions which are directed to the attention of a particular individual, usually by adding the person´s name in the utterance.
  E.g.: “what other things do you want? Jason?”

- Confirmation checks are questions which aim at ensuring audience´s understanding of the discourse. They also include clarifications requests that tend to occur whenever there is a breakdown in communication or a failure in understanding. E.g.: “ok? Do you understand?”, “pardon?”, “excuse me, what do you mean by that?”, “did you say…?”

- Procedural questions are those which refer to how to proceed in the class. They focus on the development of a certain activity or the lecture itself, but not on content or language.
  E.g.: “This is another point?”

- Repetition questions are those seeking for the repetition of the last word, utterance, idea, argument, etc.
  E.g.: “increase demand, what was the second thing?”

- Language questions are those which ask for some kind of help or support as regards the vehicle of instruction, be it the exact word needed in a specific context, the appropriate terminology in relation to the subject taught, etc.
  E.g.: “¿cómo se dice cuando te cubres en, con las acciones?”

- Indirect questions are those which are embedded in the discourse and are not uttered to get a response, but to exemplify some situation.
  E.g.: “the company's only giving them a small portion of it, so they're like **why, put in the effort?** if, if nobody, you know, they're gonna reap all the rewards”.

- Questions seeking explanation are those which request further explanations, illustration or more elaboration on the part of the teacher.
  E.g.: “All the parts of the company should be centralized?”

- Questions seeking confirmation are those which request confirmation or approval by the teacher as a sign that the speaker who asks is on the right track.

E.g.: “But, doesn’t it have to do with macroeconomic conditions?”

Third, the categorization was complemented with a quantitative analysis by calculating the frequency of use of the aforesaid linguistic phenomena in order to get a clearer image of the findings encountered and ease the comparison of the six lessons. The results were finally displayed in bar graphs and tables; thus, providing a visual representation. A statistical analysis was not implemented for reasons of data size.

The analysis of the data includes three comparisons, which allows an examination of the transcripts from varied perspectives and going from the more generic to the more specific findings. To begin with, lectures were contrasted taking into account the role of English (as the mother tongue – L1 – or the foreign language – EFL – of the classroom participants) as the main variable. As the next step, lectures were grouped only regarding the subject matter and irrespective of the role of the language of instruction. Therefore, the main variables in the comparison were Business, Engineering and Physics and questions were analyzed regarding these three different disciplines. Finally, all the lectures were divided into pairs according to their subject content and the role that the English language played on them (EFL or L1). Accordingly, they were labeled Business EFL / L1, Engineering EFL / L1 and Physics EFL / L1. All the comparisons make a further distinction between teacher-initiated and student-initiated questions.

It is important to highlight that questions triggering interaction between teacher and students and also those which do not result in any communicative exchange have been considered and analyzed in the present paper. Likewise, it is relevant to mention that incomplete utterances of the type “can I …?” and also answers by students encoded as questions with rising intonation that express uncertainty have not been considered questions as such. In addition, chains of questions are very pervasive in teacher discourse. When calculating frequencies, all questions forming a chain have been counted; however, the whole chain has been treated as one single question when calculating

interaction since it is typically just the last question of the chain the one answered or finally addressed by students in their output.

Although a large number of excerpts from the lectures dialogues are used to illustrate the discussion of results, all the lectures are attached to the present study in CD-rom format and some examples of the actual analysis and categorization are shown in the appendix section. All the questions found are tagged according to the following labels:

| **Question taxonomy** | **Labels used** |
|---|---|
| Display questions | DIS |
| Referential questions | REF |
| Rhetorical questions | RHET |
| Retrospective questions | RET |
| Self-answered questions | SA |
| Personal addresses | PA |
| Questions seeking explanations | SE |
| Confirmation checks | CON |
| Procedural questions | PRO |
| Indirect questions | IND |
| Repetition questions | REP |
| Language questions | LAN |

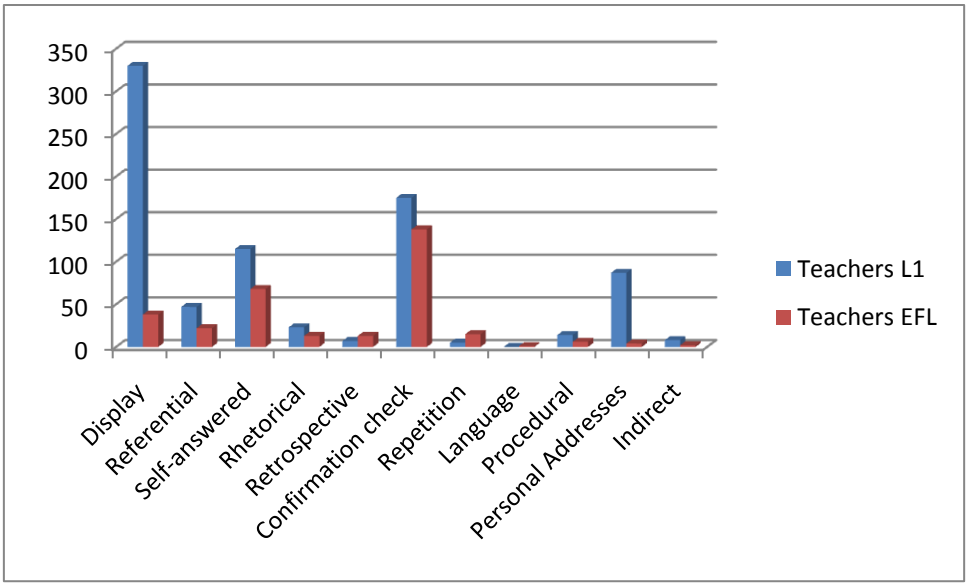
# 4. RESULTS AND DISCUSSION

The present analysis examines the role played by questions as interactive devices in six tertiary CLIL classrooms. In three of them English is a foreign language; while in the other three, English is the L1. The lessons analyzed have a common pattern: they are teacher-led classrooms and, as a general tendency, all the interaction happens as the result of the teacher asking questions to the students about the content being dealt with. Consequently, the students´ contribution was predominantly based on the reply to those questions, to which the teacher may or may not offer extra comments depending on the specific lecture. Thus, classes follow closely an IRF pattern.

This chapter presents the results of the data analyses undertaken in this study. The results are provided from the more general to the more specific aspects and findings. First, an overview of EFL and L1 lectures is offered, followed by a comparison of questions in three different disciplines and finally, a more in-depth examination of each question category in each lecture.

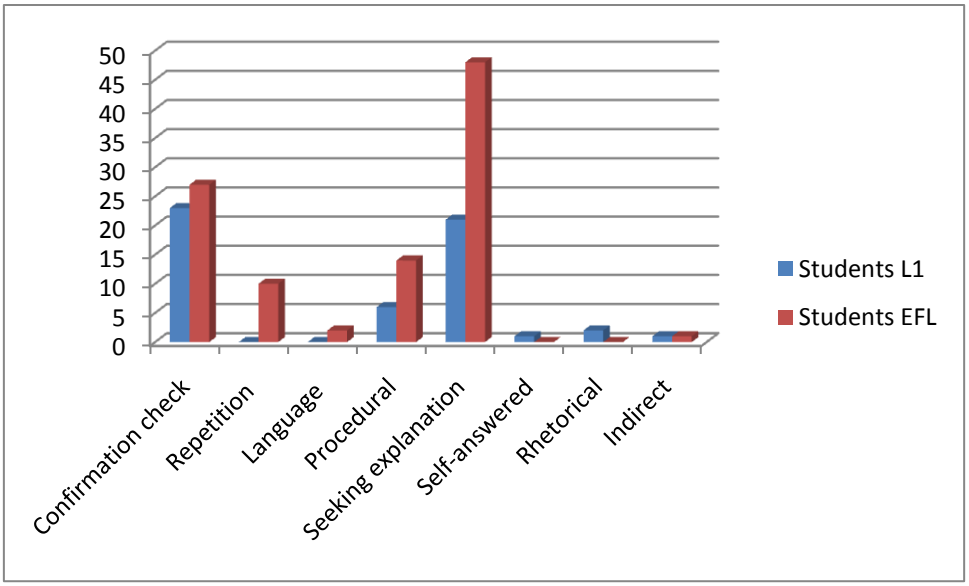
## 4.1. EFL vs. L1 lectures

One of the variables considered in the present study is the role of the English language as the vehicular medium of instruction. Of all the six lectures analyzed, 3 of them are conducted in English as the first language of students and teacher, whereas the other 3 lectures have English as a foreign language.




Graph 1. L1 vs EFL teacher question taxonomy

Instructors teaching through their mother tongue use a higher number of questions (n = 811) than teachers employing a foreign language as a medium of instruction (n = 320). The most pervasive question type in the L1 context is display questions, which somehow reveals that in the US there is an already established tendency towards actively involving the students in the lesson and in their own learning by addressing questions to them. It is a very straightforward way of letting them know that interaction is welcome in their lessons and that expressing their opinions, reasoning and sharing ideas is even a must within the classroom. In the Spanish tertiary contexts, despite late efforts to change mainstream teacher-centered classes, the more traditional teaching styles in which the teacher still remains the focus and the only provider of knowledge bias they way in which lectures are developed. This is supported by the kind of questions that tend to occur in the classrooms: confirmation checks and self-answered questions, which work as discourse structuring devices and, in some cases, trigger interaction among participants; and to a lesser extent display questions to students. Accordingly, questions unveil cultural differences affecting the way in which classes unfold and the roles played by each participant.




Graph 2. L1 vs EFL student question taxonomy

Further examination of students´ questions also bearing in mind whether the vehicular language is their mother tongue or a foreign language highlights interesting trends. While in the L1 classes students produce a total number of 54 questions out of which 23 are confirmation checks and 21 seek further explanations; the EFL students double their counterparts asking 102 questions and offer a more varied array of purposes within their main concerns. 48 of those questions aim at obtaining explanations, 27 are confirmation checks, 14 are doubts about procedural issues and 10 inquiries require repetition.

It goes without saying that by the results obtained and displayed in the two graphs above, both content and language influence the production and distribution of questions in these educational settings and also the type of questions that tend to predominate in each context.

In the lectures where English is the L1, display questions on the part of the teacher, and confirmation checks and questions seeking explanations on the part of the student may stand out content as the prime focus. All these questions articulating discourses and interaction between participants function as devices that put in evidence whether students possess certain knowledge either to progress in the delivery of new content or to go back over it if there are

difficulties. Students also ask and work towards the consolidation of the new subject matter and by means of questions demand further illustrations and/or clarifications to grasp all the information that is provided and make it become intake.

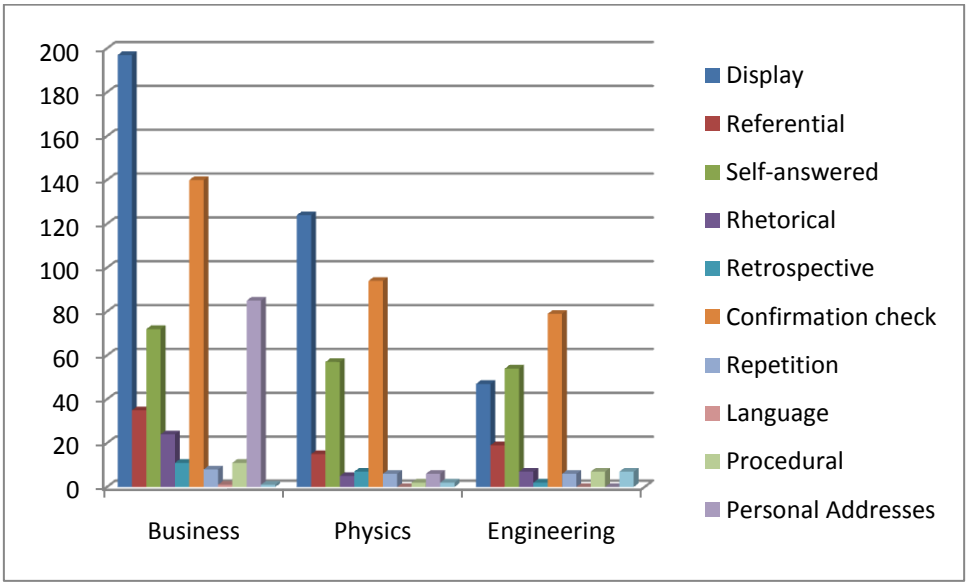
In the EFL lectures, content is also foregrounded, and the same types of questions present in the L1 lessons take place in the EFL classrooms. Yet, the frequency and distribution vary and language may have something to say in that respect. Language being a central issue as a foreign language and medium of instruction is not only hinted by the fact that there are quite a few questions regarding language form and meaning in the EFL lectures, whereas it is something inexistent in L1 settings. In addition, teachers´ discourse manifests language-related needs and is structured accordingly not only to assist the instructor in the delivery and argumentation of ideas, but also to give a helping hand to students´ comprehension and understanding. For this reason, discourse structuring questions such as self-answered inquiries, confirmation checks and even rhetorical questions are present in the speech of instructors teaching through a foreign language, and display questions, that usually emphasize content (although content could not be expressed without using language), are outnumbered by the first ones.

Students´ questions trace a similar picture by demanding assistance in more assorted aspects than L1 students. As shown in Graph 2, it seems that EFL students need more help as regards class proceedings, call for frequent repetition and their language status requires explicit instruction and continuous reinforcement to promote and strengthen their skills.

### 4.2. A focus on disciplines

In the analysis of the discourse of six lectures accounting for eight hours and 45 minutes of teaching practice a total number of 1131 teacher-initiated questions was identified. Their distribution across the three different disciplines was the following: 585 questions were produced by the teacher in the business lectures,

318 were uttered in the physics realm and 228 took place in the engineering lessons.



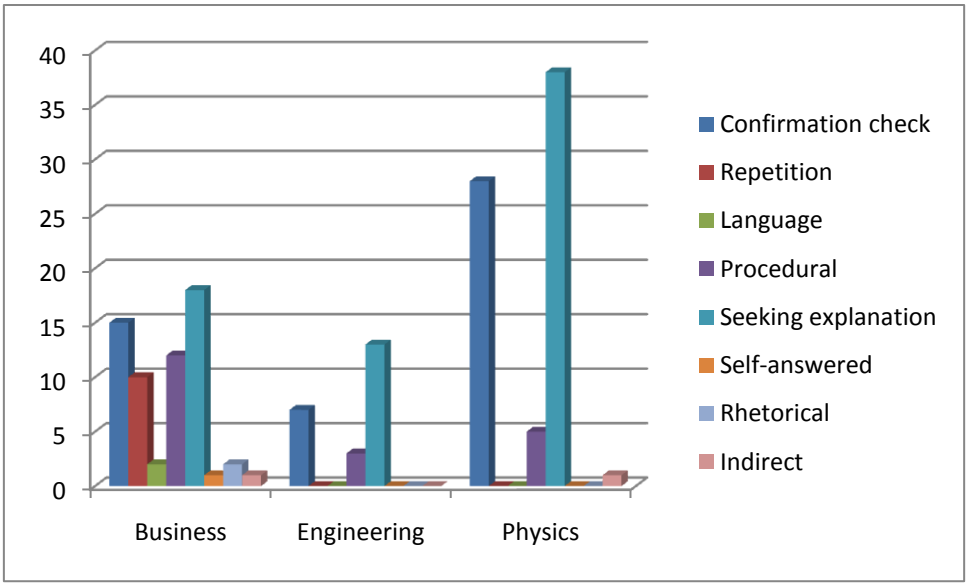

Graph 3. Teacher-initiated question taxonomy in three different disciplines

A closer look at the discourse of each discipline shows that the four question types more frequently used are common to all the lectures, even though they may rank in different order. Therefore, it could be stated that teachers tend to ask a lot of display questions and confirmation checks to their students (in some cases directing their speech to the attention of particular individuals as shown by the high frequency rate of personal addresses in the business lectures). Moreover, these confirmation checks and self-answered questions also play an important role in classroom discourse although their main functions do not trigger interaction among participants. However, they are very convenient in assisting all parties throughout discourse delivery, understanding and processing. As a consequence, it seems that monitoring and checking students´ knowledge on the subject and making them take active part in the classroom are paramount goals on the part of the teacher, regardless of the subject taught.

In addition, these findings may suggest that there is a general macro-structure that governs lectures as such. Consequently, lectures seem to follow a similar pattern when the large-scale or global distribution of lessons is examined, irrespective of the content subject dealt with. That is the reason why

the most recurrent types of questions are commonly shared between all lectures in the present corpus. And the main differences arise in the micro-structure, when small-scale features of lectures are distinguished through more fine-grained analyses.

The main difference observed in the comparison of disciplines is marked by the most recurrent question types in the engineering lectures, which are still the same categories mentioned before regarding business and physics, but occurring with distinct frequency rates. The most predominant questions in these lessons are display questions (n = 368) and confirmation checks (n = 313), followed by self-answered inquiries (n = 183). This fact invites reflection on the importance that the assorted teaching styles, methodologies and activities carried out in the particular classes have in the discourses analyzed and the results found. It could be stated that in general terms there is an overall tendency towards a higher amount of theoretical explanations in the business classes. On the contrary, the engineering lectures tend to evolve around problem-solving tasks of a more practical nature. In between these two poles of a continuum stand the physics lectures since they are characterized by devoting some time to theory matters followed by more dynamic activities such as the solving of mathematical and numerical problems. However, the aforementioned descriptions are just a few strokes of the brush. The fact that the business lectures tend to focus more on theory does not imply that they are more teacher-centered and less interactive. Indeed, the business lectures are the ones presenting the most varied question types when it comes to the students, as it can be observed in the graph below.




Graph 4. Student-initiated question taxonomy in three different disciplines

Obtaining further explanations and the confirmation of their ideas and knowledge by the expert teacher is the most relevant purpose targeted by students´ questions. These two main urges are followed by the solving of some procedural issues that may arise during the class in both engineering and physics. In addition to this, business students seem to have more difficulties as far as the questions that they ask reflect. They have a higher number of procedural problems and need repetition and more assistance with language matters, especially in the EFL business class.

The students that get more involved asking questions are those attending the physics lessons, producing a total of 67 questions. With a lower number of questions follow the students of business, asking 61 questions, and finally, 23 questions are uttered by the students of engineering.

Nevertheless, the number of questions is not a transparent sign of interaction, if we acknowledge that not all questions trigger and foster a verbal exchange among participants. Accordingly, a further analysis of the questions that do trigger some type of interaction is offered:

| | Business | | Physics | | Engineering | | |
|---|---|---|---|---|---|---|---|
| | EFL | L1 | EFL | L1 | EFL | L1 | **Totals** |
| **Total Questions** | 243 | 403 | 107 | 283 | 72 | 179 | |
| **Total Total Questions** | 646 | | 390 | | 251 | | 1287 |
| **Questions Interaction** | 90 | 143 | 46 | 146 | 38 | 18 | |
| **Total interaction** | 233 | | 192 | | 56 | | 481 |

Table 3. Total questions and questions triggering interaction

Surprisingly enough, in the business and physics lectures, there is a direct correlation between the overall number of questions and the total that triggers interaction (that is, a verbal response from the hearer as a reaction to an inquiry). The business lessons are the ones containing the highest number of questions (646) and highest number of interactional inquiries (233) as well. In the second place are the physics lectures, with a total number of 390 questions out of which 192 trigger interaction. And last, but not least, the engineering lessons rank in the third place with 251 questions from which 56 promote interaction.

Special attention should be drawn to the fact that it is typically the L1 lecture that produces the greater amount of questions as a whole and as triggers of interaction. The only exception is the case of engineering, in which the L1 setting contains more questions, but it is the EFL context that produces more interactive inquiries. The reason for this result could be two-fold. First of all, many of the display questions uttered by the teacher in the L1 setting did not produce verbal output. Second of all, there are plenty of student-initiated questions in the EFL class, probably as the result of the insufficient collaborative role played by the instructor.

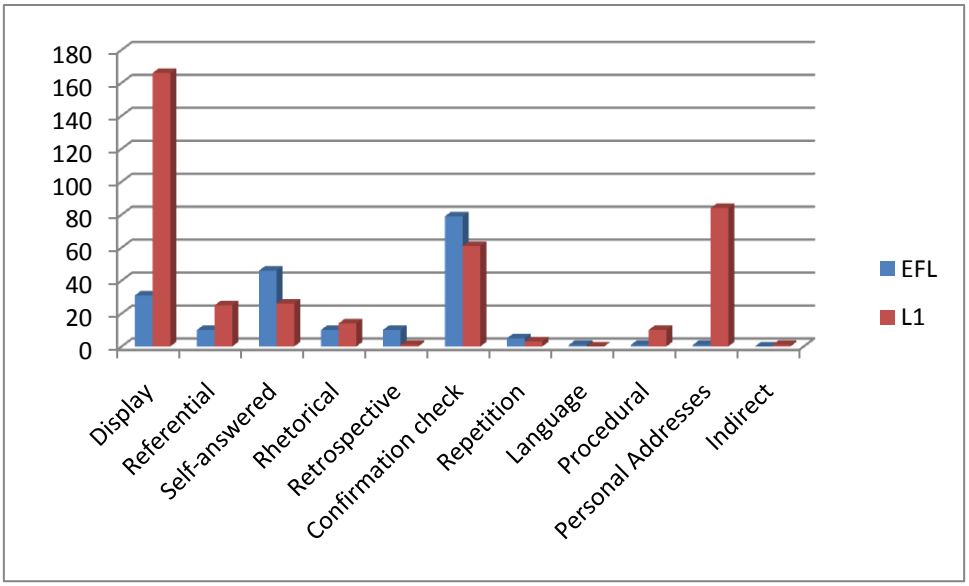
As a conclusion and relying on the aforementioned, it is important to highlight that despite the more theoretical and teacher-led nature of subjects, as it happens in the present business corpus, lessons can always be turned into more dynamic, interactive and student-centered scenarios. The same situation could take place when lectures are intrinsically more practical, but the instructor´s performance transforms them in teacher-led and teacher-centered events, as could have occurred in the EFL engineering lecture if students did not make contributions.

### 4.3. Teacher and student-initiated questions across disciplines

After presenting findings from a general perspective taking into account two different variables separately (the role of English as the vehicular language and the disciplines taught), a more thorough and specific analysis will be undertaken in which the two lectures of every discipline will be contrasted in more detail.

#### 4.3.1. Business EFL and L1 lectures: teacher-initiated questions

Concerning the EFL business lesson, an overall total of 243 questions was found, out of which 194 were teacher-initiated questions. In contrast, a total of 403 questions took place in the L1 business lesson, and 391 were the result of teacher discourse. Even though the EFL class is outnumbered by the L1 lesson in terms of questions, both of them present a high proportion of these interactional devices because, as results will disclose below, the discourse in these two tertiary settings is primarily articulated by questions.




Graph 5. Comparison between EFL and L1 business teacher-initiated questions

Graph 5 displays the findings obtained when analyzing the wide variety of questions taking place in the EFL and L1 business lectures. As can be observed, although most of the categories within the question taxonomy employed occur in both classroom discourses, a noticeable variation can be found when the two lessons are compared.

Interestingly enough, in the EFL business class, confirmation checks (n= 79 / 41%) are the most recurrent type of question, followed by self-answered (n= 46 / 24%) and display questions (n= 31 / 16%). The table below shows the number of instances and the percentages of occurrence of each question type:

| Question types | EFL | | L1 | |
|---|---|---|---|---|
| | (n = 194) | % | (n = 395) | % |
| Display | 31 | 16 | 166 | 42 |
| Referential | 10 | 5 | 25 | 6 |
| Self-answered | 46 | 24 | 26 | 7 |
| Rhetorical | 10 | 5 | 14 | 4 |
| Retrospective | 10 | 5 | 1 | 0 |
| Confirmation check | 79 | 41 | 61 | 16 |
| Repetition | 5 | 3 | 3 | 1 |
| Language | 1 | 0 | 0 | 0 |
| Procedural | 1 | 0 | 10 | 3 |
| Personal Addresses | 1 | 1 | 84 | 21 |
| Indirect | 0 | 0 | 1 | 0 |

Table 4. Frequencies and percentages of question types

On closer inspection of the corpus, some revealing points emerged. The majority of the confirmation checks uttered by the teacher seem to be void of meaning, that is, they would be instances of automatized words that belong to the linguistic repertoire of the teacher. They appear as somehow instinctive structures that typically mark a speech boundary and, some other times, provide the lecturer with some time to think about the unfolding discourse, as the example below shows:

(1) One of the joint venture firms is local and, at least one, at least one of the parents firms, sorry, is local and the others can be, can be from abroad, **ok?** So, the local partner knows the market, the local partner gives the knowledge and everything, **ok?** (…) But, probably it´s more difficult and the costs will be, will be higher, **ok?**

As it can be seen from Example 1, “ok” is the most pervasive confirmation check used in the corpus. Besides, there is no time for a possible reply on the part of the students that would indicate whether they understand the point or not, which may be another sign of the use of these confirmation checks as filler expressions.

Self-answered questions are in line with the already mentioned confirmation checks. Although self-answered questions could be classified as display at a first approach, they also show a discourse function when examined more in depth.

(2) **Is the Corte Ingles a multinational company?** Well, they are operating here in Spain and in Portugal. Yeah, multinational. Somehow, yeah, but look, let´s talk about Banco Santander. **Where do they operate?** Spain, Britain, I don't know in Italy, States, then in every American country or nearly in every American country (…) But, we really couldn't truly call El Corte Ingles a multinational company. **Why?** Because most of the wealth they create, most of the money they create, most, when I say most I say more than 95% of the value they create, they are creating it here in Spain, only in Spain (…) If a company only operates in the European Union, could, **could it be called a multinational company?** It´s better to call it a regional company.

In this excerpt it can be seen that self-answered questions help the teacher guide himself through the on-going lecture by posing the issue that s/he considers should follow. Despite the fact that these questions could perfectly address the audience, the lecturer does not leave any space for interventions, replying himself immediately as if he were talking to himself in preparation for what he wants to communicate. These questions differ from rhetorical ones in that the correct answer to a current issue is provided directly and without delay, preventing the students from taking a moment to reflect on the matter, whereas rhetorical questions are always left unanswered and are used to make students meditate. This high frequency of confirmation and self-answered questions playing the role of discourse structuring devices for the lecturer himself may have its explanation in the status of English as language of instruction. Since the lecturer is a non-native speaker and he is aware of the fact that the students attending his lesson do not have English as their mother tongue either, he may use confirmation and self-answered questions for both his own language-related needs and those of the learners. Therefore, confirmation checks may not be intended to confirm the content, but to provide the lecturer with some extra time to think (in addition to their automatized nature), while self-answered questions serve as a self-guide to prepare and present what comes next in the on-going speech. This fact may be a sign of the multifunctionality of questions. They are typically designed or adapted to a particular function of use, usually depending on the context where they are uttered and with the aim of accomplishing the purposes that the speaker has in mind. However, it could also be the case that the perlocutionary effect of a question may differ from the intended effect of the speaker´s illocutionary act.

The aforementioned observation is supported by the finding of significantly less cases of confirmation checks and barely any instances of self-answered questions in the L1 lecture, as displayed in Graph 5 above. Accordingly, it seems possible that L1 lecturers focus more on content as regards its delivery and its comprehension by the students; not paying so much attention to language matters on the grounds that the vehicle for that content is their mother tongue and, thus, it should come more naturally to them. In contrast, and in spite of the fact that usually no explicit attention is paid to language, EFL and L2 lecturers may unfold their worries equally on language matters and content delivery and understanding.

In the L1 business lesson display questions are greatly exploited (43%), in detriment of other types of questions. Curiously, in both lectures, display questions stand out in number by comparison with their opposite, referential questions; although this variation is highly accentuated in the L1 lesson. According to the general belief that referential questions trigger responses twice as long and complex than replies to display questions, there was a well-founded expectation of finding the opposite results. Such counter-expectancy, however, does not contradict the initial prospect in terms of students´ contributions to the discourse. Even though the present paper does not aim at providing an exhaustive analysis regarding students´ responses, a clear tendency to find more personal, elaborated and longer discourse strands resulting from referential questions was noticed.

| **Display Questions in L1 lesson** | **Referential Questions in L1 lesson** |
|---|---|
| Teacher: what kind of a value do we put on that? | Teacher: so i'm curious, what's your sense of grades? is there too much emphasis on grades here? |
| Student: positive | Student 1: um, i think they're a good motivator, i think it uh, brings out competition, in our environment and, um pushes kids to like strive and be the best, you know without 'em, i would probably do like, half as much. |
| Teacher: anything else? Tariq? | Student 2: um, i think it really depen- depends on the individual because i know for me, um, i like to learn just to learn and i get pleasure out of that, and so when there's grades and, that puts a lot of um, it puts a lot of pressure that i don't need and i think it detracts from learning sometimes, so i think it really depends on whether you're, already a very motivated individual, or whether you need, like external motivation. |
| Student: your level of, income, dollars don't go up they stay the same year after year because, your expectations are going up but your your income is the same. | |
| Teacher: so this might be, a little bit more of a_ it might be a double negative cuz of what's happened here. Cheol? | |
| Student: job security goes down. because it becomes more difficult, to uh, be uh | |

Table 5. Display vs. Referential questions in the business L1 lecture

Table 5 shows that students´ responses to display questions are quite limited in the number of words in comparison with answers to referential questions. Responses to display questions range from just one word or one clause element to whole clauses. However, replies to referential questions tend to be more complex in terms of length and linguistic structures. Besides, they also contain features denoting vagueness (like), fillers (um) and macro-markers signalling students´ attitudes or beliefs (I think), whereas in display questions, answers are offered in a clearer way probably because it is knowledge already stored.

In the case of the EFL lecture, referential questions are even less recurrent. Strikingly, short answers are dominant regardless the type of question. As evidence from Table 6 displays, it could be explicable due to the fact that the majority of referential questions are predominantly closed; thus, not allowing too much interaction. It is also worth noting that there is a certain predisposition to switch to the mother tongue when referential questions come into play. This code switching may be due to the fact that questions change from an academic to a more personal context. Consequently, it could be argued that the L1 seems to be more convenient and natural when talking about personal matters, offering more confidence and assurance to the speaker.

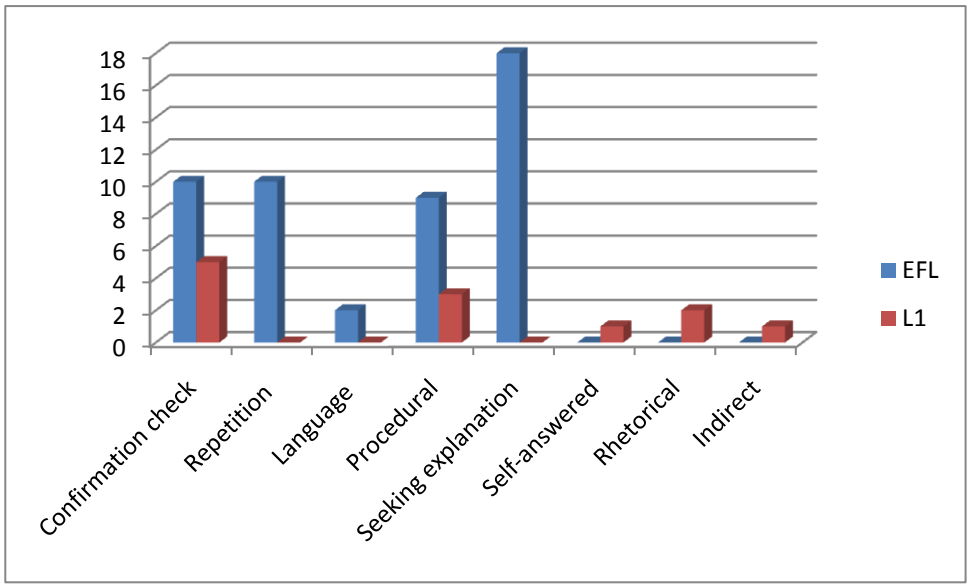
| **Display Questions in EFL lesson** | **Referential Questions in EFL lesson** |
|---|---|
| Teacher: There were three levels of strategy, which kind of decision is the globalization? | Teacher: That´s not exactly global, but think about Volkswagen. Have you seen that the commercials for Volkswagen have been reproduced in German all around the world, even here? No, only the voice, if there is a voice, has been translated, but the images haven't been. Have you seen? How do we know? How do we know? Because in the end it says "das …" That is in German. |
| Student: Corporate | Student: But every country adds the voice. |
| Teacher: Why would a firm grow global? I´ve just given you an example. | |
| Student: to make money | Teacher: you are yawning |
| Student: to share risks | Student: That´s because yesterday, last night Hospital Central pasaba revista. |
| | Teacher: Is still Bitches there? Is still Bitches there? |
| | Student: No, no |
| | Student: Vuelve |

Table 6. Display vs. Referential questions in the business EFL lecture

The second most frequent type of questions in the L1 lesson is personal addresses. Almost every question, whether it is display or referential, is directly addressed to a particular individual. It is not clear whether the instructor selects students at random or if it is students that volunteer themselves to offer their opinions by, for example, raising their hands. Whatever may the circumstance be, these personal addresses would have a tremendous influence on interaction. They could be devices exerting the lecturer´s authority and pressure on the students, especially if the teacher requires an answer from someone who did not have in mind participating in the on-going discourse. It could also show a class in which students are very involved and willing to take part.

### 4.3.2. Business EFL and L1 lectures: student-initiated questions

The data examined indicate that student questions are more predominant in the EFL business lesson. In the EFL classroom 48 questions out of 243 are uttered by learners, while in the L1 business session students only ask a total number of 12 questions out of 403. Graph 6 summarizes the findings:




Graph 6. Comparison between business EFL and L1 student-initiated questions

The overall distribution of the questioning activity on the part of students looks very heterogeneous, as Graph 6 displays.

EFL learners become very involved and findings show that the main objective of students when asking questions is seeking explanations (n= 18 / 37%). This purpose is followed by the need for confirmations in terms of content (n= 10 / 21%), and repetition (n= 10 / 20%). Examples 3 and 4 provide some evidence of the type of questions that met the aforesaid purposes in our corpus and Table 7 reflects their frequencies and percentages.

(3) Teacher: You just, you sell your product to a company which distributes it for you in that country. So, whenever your product is at another country, you are losing control over it.

Student: So, so, **what´s direct exportation then?** That´s what I have for direct exportation.

Teacher: Ok, direct exportation, you get, mmm, I mean, you won´t miss the control of your product to the point of sale, even if you are negotiating with the sales point. The sales points are not yours, but you negotiate directly with them: the conditions, supplies and so on. Know what I mean? In the other case, they buy something from you and then they sell it. That´s the problem.

(4) Teacher: Ok, let´s order it. First of all, the example that I´ve just given you: to reduce the costs (pause).

Student: **to reduce the…?**

| Question types | EFL | | L1 | |
|---|---|---|---|---|
| | (n = 49) | % | (n = 12) | % |
| Confirmation check | 10 | 21 | 5 | 42 |
| Repetition | 10 | 20 | 0 | 0 |
| Language | 2 | 4 | 0 | 0 |
| Procedural | 9 | 18 | 3 | 25 |
| Seeking explanation | 18 | 37 | 0 | 0 |
| Self-answered | 0 | 0 | 1 | 8 |
| Rhetorical | 0 | 0 | 2 | 17 |
| Indirect | 0 | 0 | 1 | 8 |

Table 7. Frequencies and percentages of question types

These results are likely to be associated with the status of English as a foreign language conduit by means of which content is transmitted. Despite the fact that

English may not constitute a serious problem impeding student communication and comprehension of content in the CLIL classroom, it may require an extra effort on the part of the learners (as well as on the part of the teacher, as it was previously observed) since learning through English could become a very demanding enterprise. Accordingly, non-native students may feel the necessity to check and corroborate information by asking for confirmation, repetition and further explanations and/or illustrations to assimilate and make sure that their learning is on the right track.

According to the data, procedural questions addressing the structure of the lesson and the delivery of the content are also very pervasive in the EFL business lesson, which may indicate a possibly lack of discourse markers and, consequently, students need to find out some guidance as the teacher discourse develops. The following students´ remarks also exemplify the point being discussed.

(5) Student: **But are we talking about the image the firm is trying to get or the strategy that the firm is trying follow or the actual performance of the firm in the country?** because….

(6) Student: **But this is the Porter model also?**

(7) Student: **So the alternatives are not inside the Porter model?**

Concerning the L1 business lecture, it was found that the most frequent questions uttered by students are confirmation checks (34%), procedural (25%) and rhetorical questions (17%).

In the case of confirmation checks, they tend to be slang and vague words (e.g. you know?), not really seeking confirmation from the interlocutor, which would typically be their first and main role. Regarding the procedural questions, findings do not match the role that they play in the EFL lesson. In the L1 lecture, their frequency respond to the nature of the activities carried out in class. Since there are several improvised role plays and group discussions, students need information from the teacher on the proceedings to follow. Therefore, procedural questions may not typically be as frequent as they are in this lecture since they seem a product of the specific circumstances of that

concrete lesson development. These are some of the instances taking place in the lecture:

(8) Teacher: anybody here w- wanna play Jay? anybody here from the Florida sales team? Anyone okay. go ahead, Brenda, you're having a conversation with Jay. you gotta get_ you have a plan of action go ahead. you have some ideas let's see the follow-through (…)

Student: **I'm starting?** okay.

Teacher: yeah you're you're you're the researcher go ahead.

Student: **and who am I?**

Teacher: Jay

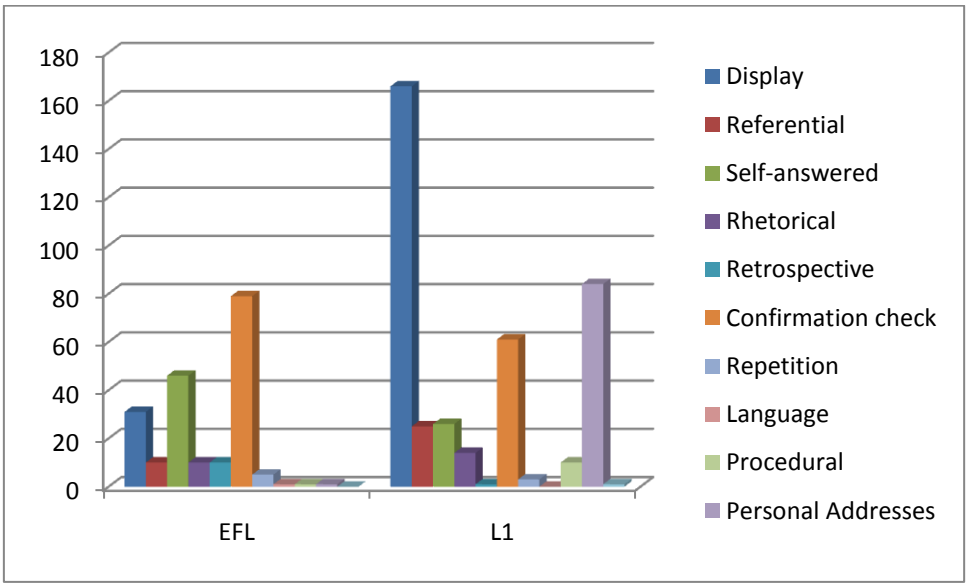
Student: alright

Finally, it is rhetorical questions that according to the data analyzed seem to be recurrent within students´ output. However, there is nothing striking in their use. They are just part of the on-going discourse of students, especially as responses to referential questions, and are presented as food for thought and as an important point to contemplate on the part of the students.

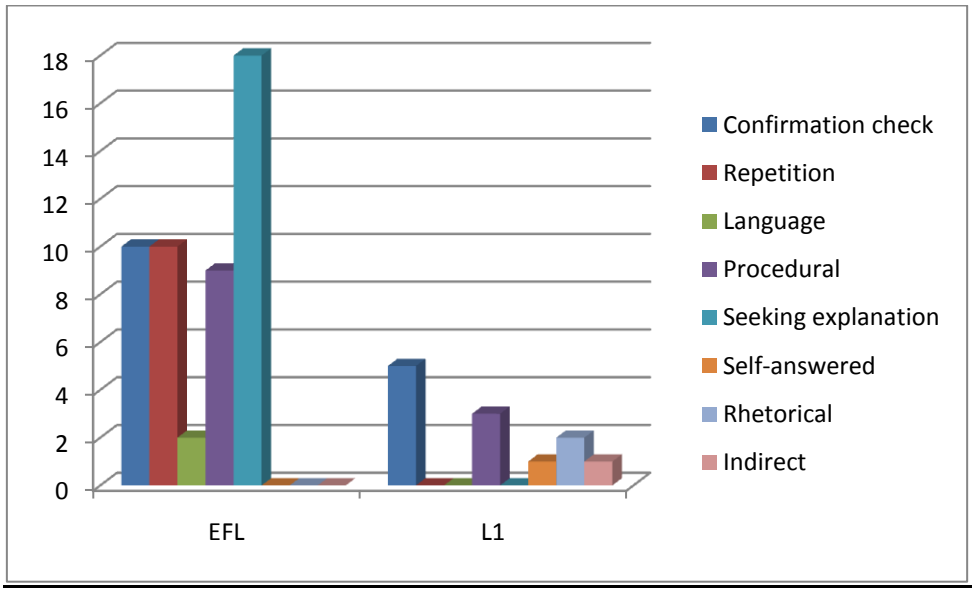
(9) Student: you've got the best students, but the first thing they tell you when you come here is that, most of you are gonna get a B-minus or a B-flat. i mean, you're taking the best students, and you're telling them that all of you are gonna get different grades, **where's the question of, me, being rewarded for what i am?** rather than me being placed in one bell curve and say hey you're there, you know? **where's the reward factor?** i work my_ weekends i work Sundays but i'm not going to get rewarded because i know that, there's a curve that's facing me you know, it's not me so grades don't really reflect my effort.

Special attention should also be drawn to self-answered, rhetorical and indirect questions as moves by the students. Whereas there are no instances of these types of questions in the EFL lesson, L1 students tend to include them in their speeches. This result may indicate that L1 students have a larger and more extensive linguistic repertoire, which the EFL students still lack. Therefore, native speakers of English seem to be able to express ideas in many more ways and use a higher number of different syntactic structures than their EFL counterparts, who might have a more limited command in their foreign language, as could be reflected by these data.

There is a finding that is worth a look. When teacher- and student-initiated questions in both the EFL and the L1 lectures are compared, it is very significant the fact that patterns are totally reversed. It can be thus said that EFL teacher and EFL students as well as L1 teacher and L1 students´ questioning patterns complement each other. The following graphs provide evidence:




Graph 7. Comparison between business EFL and L1 teacher-initiated questions

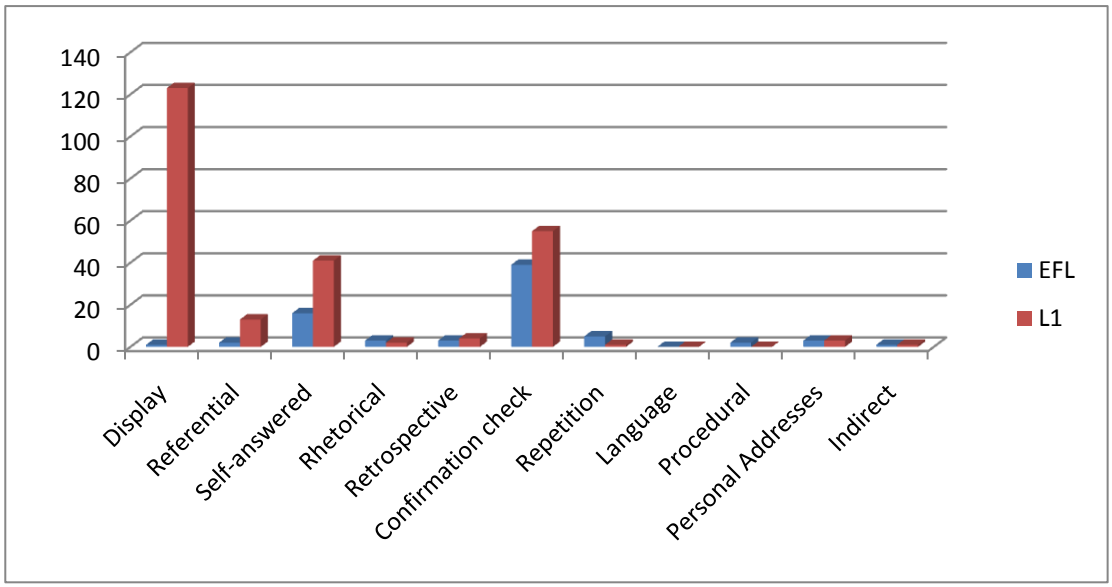



Graph 8. Comparison between business EFL and L1 student-initiated questions

As Graph 7 and Graph 8 display, there seems to be a complementary role when it comes to the distribution of questions. Teacher-initiated questions follow totally reversed patterns (there is a higher number of questions uttered by the teacher in the L1 context than in the EFL setting), and the same happens with student-initiated questions (EFL students ask many more questions than L1 students). Nevertheless, teacher and students´ questions seem to complement each other in every lecture; thus, showing a tendency in which the more inquiries asked by the teacher, the less student contributions. Likewise, the fewer the questions the teacher asks, the more students´ oral interventions.

### 4.3.3. Physics EFL and L1 lectures: teacher-initiated questions

In reference to the EFL lecture, questions amounted to 107, out of which 75 resulted from teacher discourse. Set in opposition is the L1 lesson with an overall total of 283 questions, 243 being teacher-initiated. Strikingly enough, both lectures present quite a parallel distribution; a great number of display questions in the L1 classroom being the only feature setting both lectures apart.




Graph 9. Comparison between physics EFL and L1 teacher-initiated questions

The analysis of the data, as displayed in Graph 9, reveals that the physics lectures examined are notably homogeneous in terms of questions types. In the EFL lesson confirmation checks (n= 39 / 52%) in the first place and self-answered questions (n= 16 / 21%) in the second place appear as the most recurrent questions asked by instructors. Regarding the L1 lesson, display questions (n= 123 / 51%) stand out conspicuously from the other categories, followed by confirmation checks (n= 55 / 23%) and self-answered questions (n= 41 / 17%).

| Question types | EFL | | L1 | |
|---|---|---|---|---|
| | (n = 75) | % | (n = 243) | % |
| Display | 1 | 1 | 123 | 51 |
| Referential | 2 | 3 | 13 | 5 |
| Self-answered | 16 | 21 | 41 | 17 |
| Rhetorical | 3 | 4 | 2 | 1 |
| Retrospective | 3 | 4 | 4 | 2 |
| Confirmation check | 39 | 52 | 55 | 23 |
| Repetition | 5 | 7 | 1 | 0 |
| Language | 0 | 0 | 0 | 0 |
| Procedural | 2 | 3 | 0 | 0 |
| Personal Addresses | 3 | 4 | 3 | 1 |
| Indirect | 1 | 1 | 1 | 0 |

Table 8. Frequencies and percentages of question types

Further examination of the EFL lecture highlights two interesting trends regarding self-answered questions.

(10) Teacher: **what happens if another dislocation is coming after this one?** It will find not only the obstacle, but also the dislocation loop in here. So, it will have a more complex interaction.

(11) Teacher: (...) I have a carbon precipitate. I have just some impurities of carbon in my matrix, but they are just what is called a solid solution (...) **What happens?** We can have two possibilities. If the impurity atom it is of smaller size than the one from the matrix, then we will have some tensile stresses on the surrounding lattice. While if we have that the impurity it is bigger one, then I will have compressive stresses in the lattice.

Example 10 shows the use of self-answered questions as a simple guidance on the part of the teacher throughout the unfolding discourse not only to assist his own language-related needs, but probably also his students´ (as it has been previously explained in the business EFL lecture). However, this type of question may also serve another function, that of a topicaliser. As Example 11 illustrates, many times the instructor introduces a new topic by directly encoding it in the form of a question or by posing a question whose answer (always provided by the teacher) contains the new information. Therefore, self-answered questions could be employed to precede new subject content, but also to mark some concept or idea as the current topic.

The most noticeable variation observed in self-answered questions taking place in the L1 setting is the fact that they have an extra function as elicitation tools which has not been found in any of the previously studied lectures. They seek a certain reply from the students; yet, it is the teacher the one providing the correct answer without delay and without providing any time for the students to produce the expected output. Examples 12 and 13 show how a self-answered question by the teacher tries to elicit a specific answer by the learner, but its potential eliciting function is not fulfilled because of the prompt instructor discourse. Consequently, in both lectures on physics there is evidence showing the varied exploitation of self-answered questions in classroom discourse.

(12) Student: you mean it'd just be constant?

Teacher: not constant if it was monoenergetic **, it would be a?** delta function, it would be delta V-X minus whatever the, speed of the beam is.

(13) Teacher: which is delta equals zero?

Student: (xx don't know)

Teacher: you don't know. So in fact, you want something, that destroys all the fringes, **except the?** delta equals zero fringe. Is that clear?

The findings regarding confirmation checks in the physics lessons are in line with those encountered in the EFL and the L1 business lectures. It seems clear that they are automatized words belonging to the linguistic repertoire of the speakers and discursively working as fillers. Nevertheless, an interesting point emerged when analysing the physics L1 classroom.

(14) Teacher: for each velocity class, equals some number [S3: oh ] W in order V, **alright? [S3: yeah ]** Now when we start to put in (...)

(15) Teacher: (...) How the atoms come out along the beam, right so there's a different, probable velocity associated with the longitudinal motion, and the transversh mot- transverse motion. [S3: okay ], **alright? [S3: mm, yeah ]** So for V-perpendicular in fact we take some theta (...)

These extracts show that confirmation checks are followed by the students even when no wait time is provided and the teacher does not stop his conversation flow. Therefore, it could be argued that even though the majority of confirmation checks are uttered unconsciously, they play a significant role in discourse and content delivery. In a very subtle way they mark pauses and boundaries throughout the lecture; thus granting the lecturer with extra seconds to figure out how to proceed, and likewise signalling a stop in the learners´ mind as they process information. It is at that time when students self-confirm that they follow the discourse so far and feel certain of their comprehension and understanding. Hence, these “yeah” could be considered the aloud reflection of that checking inner thought or mental response. On the contrary, if the speech was not grasped, high chances would be that questions rose on the part of the student. As a consequence, and even though it is believed that our mind has the ability to ignore or cut out fillers and any speech dysfluency occurring within the flow of and otherwise fluent speech, confirmation checks may be a window to cognitive and learning processes as they happen.

Further insights about the physics lectures come from the analysis of display questions, which, strikingly enough, are virtually used in the EFL class. This type of questions tends to be the most fundamental discursive tool for engaging students in classroom interaction. Besides, it is the answer to these questions and, to a lesser extent, to referential questions that constitutes most

of the students´ oral production in the classrooms. Thus, the EFL physics lecture presents a much more monological and conversational style than the L1 physics lesson, especially regarding the scarce opportunities in which students can get involved in extended discourse.

As a counterpoint, the L1 lecture is found to be characterized by a great amount of display questions, quite a few referential questions and also clear instances of negotiation of meaning. Display questions aim at verifying if the learners possess certain knowledge on the subject and, in the particular lecture examined, they are recurrently used in physics problem-solving exercises.

The more relevant distinction with regard to previous lectures seems to be the appearance of display questions which do not result in students´ verbal output.

(16) Teacher: **What phases are you comparing? *<PAUSE:06>*** there's only two frequencies in the problem... aside from Doppler shift. one is the frequency of the?

Student: atom

(17) Teacher: So if you multiply all those out, you end up with, K V-perpendicular T, is on the order of ten-to-the-fourth... well, **what does that mean? *<PAUSE:11>*** this is the Doppler shift that the atoms get because of their transverse motion (...) what'll happen to all these phases...?

Student: they'll just cancel each other out

The excerpts above illustrate that despite the fact of being provided with thinking time, students do not produce any kind of output as the result of teacher´s display questions. Although at a first approach it may seem to reflect a problem of content, that is, that learners do not have the knowledge that is being asked from them, on closer inspection it can be observed that the obstacle encountered by the students may reside in the wording of the question itself. After the long pauses, the instructor attempts to elicit the answer that he is looking for by reformulating the former display question. In this second opportunity, students respond, which could indicate that even though the

language of instruction is their L1, problems understanding what they are asked for also come into existence.

All these meaning difficulties that have been discovered in the L1 physics lecture give rise to an extremely interesting point by which the L1 lesson is typified: negotiation of meaning. The reformulation of questions and any other possible modifications applied to an original utterance or question make the comprehension of message meaning easier for the learner. There is a high number of these strategies as part of the teacher´s speech in the L1 lecture. However, it is something missing in the EFL classroom, even though it may result very helpful for the acquisition and/ or comprehension of an L2. An example about the negotiation of meaning through reformulation in the L1 lecture is the following:

(18) Teacher: alright... **so this gives you a width that depends on what?**

Student 1: (laws)

Teacher: **as the length gets larger and larger, what happens to the width?**

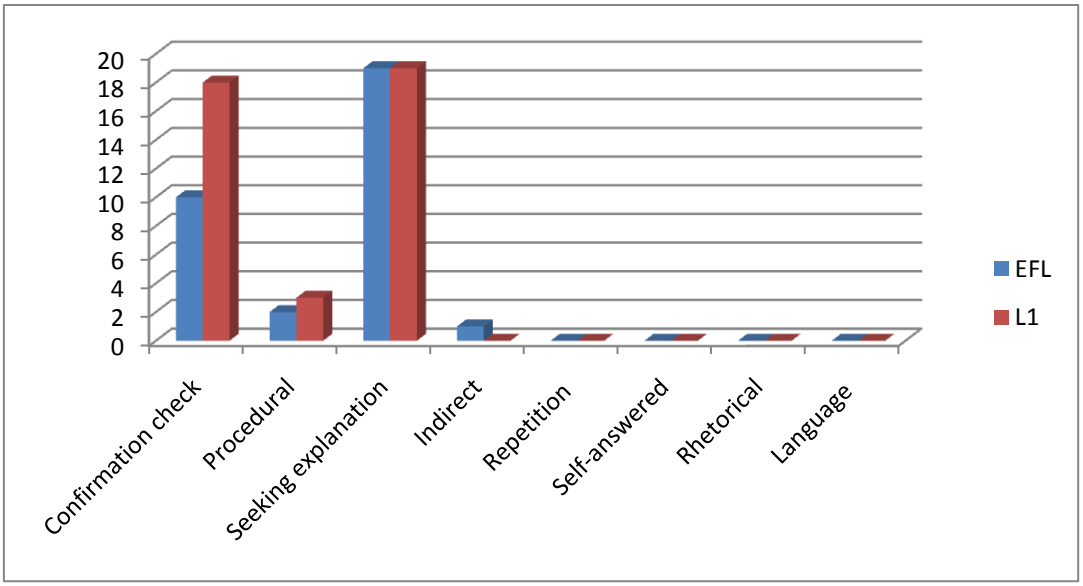
Student 1: gets smaller

Student 2: smaller

Teacher: smaller and smaller so it looks like you have arbitrarily small width.

### 4.3.4. Physics EFL and L1 lectures: student-initiated questions

Results indicate that questions posed by students in the physics lessons do not differ from one another to a high degree in terms of their frequency. Neither are they different as far as question types are concerned. 32 questions out of 107 are uttered by learners in the EFL classroom, whereas 40 out of 283 are student-initiated in the L1 lesson.




Graph 10. Comparison between physics EFL and L1 student-initiated questions

As it can be observed from Graph 10, both lectures present similar levels of interaction as it is initiated by the students. The main purpose of learners questions is seeking for explanations (n= 38 / 53%), followed by confirming their ideas and/ or speculations (n= 28 / 39%), and finally, solving some doubts about classroom proceedings (n= 5 / 7%)[4]. The following examples provide some evidence:

(19) EFL Student: Why do we have that step in the beginning?

(20) EFL Student: But, what these stresses come from?

(21) L1 Student: why they in the Doppler now they have, the exponential, um, Us, um U-X, uh, U, is that?

(22) L1 Student: how does it compare with delta?

The most pervasive type of question by students relates to content matter. What makes the learners interact and ask a question is uncertainty, the urge to know more about the subject matter being explained, the quest for further examples or knowledge, or the desire to go into a certain topic in depth. The table below shows the frequencies and percentages regarding question types:

[4] Both the EFL and the L1 lectures are considered together.

| Question types | EFL | | L1 | |
|---|---|---|---|---|
| | (n = 32) | % | (n = 40) | % |
| Confirmation check | 10 | 31 | 18 | 45 |
| Repetition | 2 | 6 | 3 | 7 |
| Language | 19 | 60 | 19 | 48 |
| Procedural | 1 | 3 | 0 | 0 |
| Seeking explanation | 0 | 0 | 0 | 0 |
| Self-answered | 0 | 0 | 0 | 0 |
| Rhetorical | 0 | 0 | 0 | 0 |
| Indirect | 0 | 0 | 0 | 0 |

Table 9. Frequencies and percentages of question types

A remarkable finding is the several students´ answers to display questions which are encoded in the form of inquiries and which are characterized by rising intonation.

(23) Teacher: so, what does K cross K cross E give us?

Student 1: dot-squared-E?

Teacher: no remember use the (back cav, row) alright you don't have to er- it's K times, K dot E. But, what is K dot E?

Student 1: it's, zero.

Teacher: zero, because K is perpendicular and then you get minus E times, K dot K, but K dot K is, kappa is just

Student 1: zero?

Teacher: K. K dot kappa kappa's in the direction of K.

This extract from the L1 physics lecture reveals some level of uncertainty on the part of the students when it comes to content knowledge. These kinds of questions may prove good evidence that the level of the content presented in the classroom adjusts to the learning needs of the students and constitutes an instance of comprehensible input; thus supporting effective learning by fostering the cognitive engagement of students and challenging their high-order skills. Consequently, learners do not get bored in the class as the result of knowing

and being able to solve all the challenges introduced, but they have to think carefully, reason and apply previous knowledge. Although as observed from the previous example, students are not completely sure whether their answers are correct, it is evident that they follow the lesson, make choices and attempts to succeed in problem-solving tasks by interacting despite the brief output they produce. It is also important to notice the support and scaffolding provided by the teacher after each (correct or wrong) answer; hence positioning himself as a facilitator.

In the case of confirmation checks (the second most frequent student-initiated type of question in both lectures), they give rise to a new class of concept; thus contrasting with all the confirmation checks encountered and analyzed so far, those which pertain to casual, slang and vague speech. These new confirmation checks are realized by complete clauses, not just single words, conveying beliefs, facts or ideas for which the students require the teacher´s verification, approval and/or clarification so as to confirm that they are on the right track (as illustrated by Example 24) and are understanding, processing and storing information correctly (as shown in Example 25).

(24) Student: Are we taking K-one and K-two to be, in opposite directions?
Teacher: **not not** yet we're just taking 'em arbitrary

(25) Teacher: what would the longitudinal velocity distribution be?
Student: two, you mean it'd just be constant?

These instances of confirmation checks take place as part of both the EFL and L1 lecture discourse and emphasize a difference when compared to the kind of confirmation checks produced by teachers, taking into account their form and also their meaning and function in speech.

During the analysis, another feature that came to the forefront was the use of the L1 (Spanish) when using regular confirmation checks in the EFL physics lesson.

(26) Student: the first one will, I don’t know, lose energy, **¿no?**

(27) Student: Do you know this kind of, of… [Student: For example…] questions take a lot of [Teacher: time to…] time, **¿no?**

The rationale behind this use could be the fact that there is a natural tendency to change to the mother tongue when unawareness comes into play, in this case in the form of confirmation checks since they tend to be unconscious linguistic moves. This account could be supported by the similar occurring predisposition to switch from the L2 to the L1 when it comes to personal matters, as exemplified with referential questions and answers in the EFL business lecture.

After the analysis of students´ questions and also students´ answers to display and referential questions, special attention should be likewise paid to the answers by teachers to the main questions asked by their learners, which are those seeking for explanations and confirmations.

| EFL Questions for explanations | L1 Questions for explanations |
|---|---|
| Student 1: there is some kind of bonding or there is no bonding? | Student 1: how does it compare with delta? |
| Teacher: Yes, yes,of course, we have a grain boundary, in fact we have an energy boundary. We have a boundary energy between them, and to separate the material, then you have to break this bonding energy | Teacher: delta's not_ delta's fixed, and we'll have to deal with delta also delt- there's another phase here, that we'll have to deal with, but i want to look at this phase first. no matter what delta is it's fixed. so when we average over Vs- V- perpendicular, the signal washes out of the optical domain. so you can't do the Ramsey fringe, for these typical parameters, in the optical domain... and in fact the original experiments were done in the R-F domain, where, in the R-F domain... what changes? |
| Student 1: But it is…the grain, the bonding between two grain | Student 2: but why are we looking in the R-F domain? |
| Teacher: It's less than the one we have…yes yes. You notice. And also it is always a distorted area. You remember that it is not a completely periodic? As we saw in the XXX we were seeing imperfections, you remember? It was a disorder area, it was a surface of disordered atoms because they are not belonging to the periodic structure. Many times they have many dislocations there, other times they have some precipitates that usually precipitate on the grain boundaries, because they are like disorder areas. Okay? | Teacher: that_ that's where the or- we don't have to look in the R-F domain that's where the experiments were originally, carried out it's still an important domain. Because the frequency standards are, are, cesium for example ground state transition, so it's a transition between, between the two hyperfine states and the ground state, which is in the radio frequency part of the spectrum. It's on the order of gigahertz. so that this is in fact the region where most standards have been, developed so far it would be better if we could get an optical standard, but we're not there yet, because of other problems. so that this, is, a way to measure, for example transitions between hyperfine states... |

Table 10. Teacher answers to questions for explanations

The examples above are representative in showing that teachers´ reactions to student inquiries tend to be long monologues in which they try to make their point clear, for which they use repetition, modifications and reformulations of their statements and sometimes also questions looking for different strategies. For instance, in the EFL lecture above, the instructor asks retrospective questions to make students go back in time and in stored information and recall what they already learnt and is now again important for the new ideas being

discussed. Also, and especially at the end of their speech they usually produce confirmation questions that ensure them understanding on the part of the student.

| **EFL Questions for confirmation** | **L1 Questions for confirmation** |
|---|---|
| Student 1: So, it´s a kind of increasing the pressure in the boundary, yeah? | Student 1: two, you mean it'd just be constant? |
| Teacher: Yeah. More or less. You are really putting a lot of, a lot of stress. If you sum all the stresses you have a really high value. | Teacher: not constant if it was monoenergetic, it would be a? delta function, it would be delta V-X minus whatever the, speed of the beam is, alright? monoenergetic means you have all the, atoms have the same longitudinal velocity, alright? now out of a thermal source you don't get that out of a supersonic source you can do a lot better, and you can use laser cooling techniques actually to get close to that. |

Table 11. Teacher answers to questions for clarifications

In the case of students´ questions whose main concern is obtaining confirmation by the teachers, instructors still answer with monologues, but not so extensive as when students need an explanation. Most of the times, learners only need a “yes” or “no” that affirms their ideas; therefore, long speeches are not required.

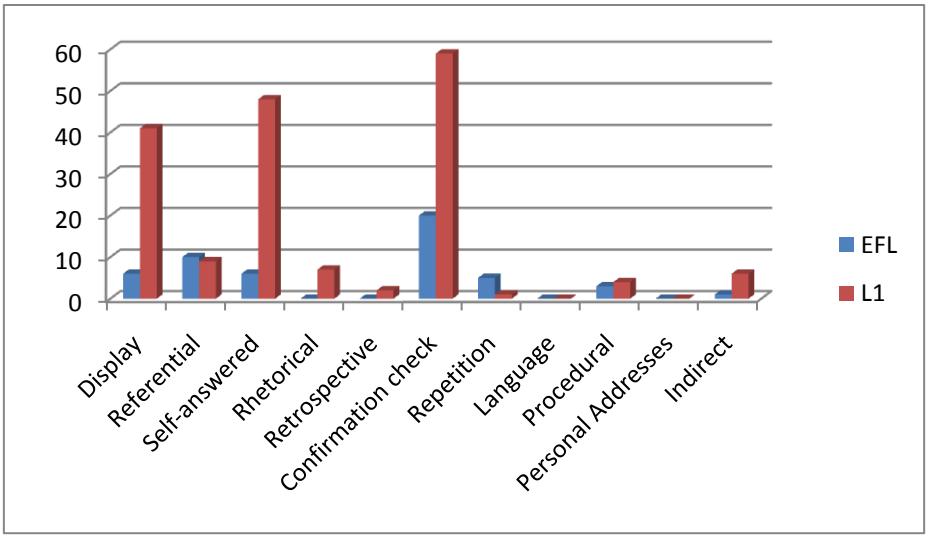
In addition, it is noticeable that answers by the teacher speaking in his mother tongue are larger in extent when compared with those provided by the EFL instructor. A possible reason for this finding could be language itself. In other words, the teacher employing English as a foreign language may not feel as comfortable using the language as the native; thus, she tries to go straight to the point and not complicate herself in the speech. The L1 teacher, however, does not think about language as a hindrance and, even if it is unconsciously, he offers a rambling discourse.

A significant variation found is that teacher´s answers to questions are typically longer, more complex and varied than those responses provided by the students when they answer to teacher´s questions. It seems obvious that both participants attempt to fulfil different goals with their oral contributions. While students may just pursue a right answer that gets back positive feedback from the teacher, the instructor strives to accomplish his students´ learning. Hence, student and teacher discourse should be articulated in following different fashions.

By and large, it is the physics L1 lecture that presents the highest interaction. Whereas in the EFL discourse there are questions amounting to a total of 107, and only 46 of those inquiries succeed in triggering interaction between instructor and learners, in the L1 lesson there are as many questions triggering interaction as the overall total of them in its EFL counterpart: 107, and a sum total of 283 questions. In addition, the EFL lecture concentrates the highest interaction, as the result of students´ queries, at the end of the session when practical exercises were corrected by the teacher, while the remaining time turns out to be more teacher-led since theoretical points are introduced and developed. Contrarily to this, the L1 lesson distributes problem-solving tasks throughout the whole session, fostering interaction at all times and evenly between all participants.

#### 4.3.5. Engineering EFL and L1 lectures: teacher-initiated questions

As a general overview of teacher-initiated questions, it has been found that of a total of 72 questions in the EFL lecture only 51 of them are part of teacher discourse. In the case of the L1 lesson, a total number of 179 questions occur, but most of them (177) are asked by the instructor.




Graph 10. Comparison between engineering EFL and L1 teacher-initiated questions

As displayed by the graph and the figures above, it seems that mostly all the interaction taking place in the L1 lesson is triggered by the teacher; however, it is necessary to carry out a more in-depth analysis since not all question categories set off responses, which means that they do not contribute to the active communicative exchange between participants. This is precisely what happens in the case of confirmation checks, which is the most pervasive type of teacher-initiated question in both lectures (n= 20 / 39% in the EFL; n= 59 / 33% in the L1). Table 12 provides a further account of frequencies and percentages of question types in these two lectures:

| Question types | EFL | | L1 | |
|---|---|---|---|---|
| | (n = 51) | % | (n = 177) | % |
| Display | 6 | 12 | 41 | 23 |
| Referential | 10 | 19 | 9 | 5 |
| Self-answered | 6 | 12 | 48 | 27 |
| Rhetorical | 0 | 0 | 7 | 4 |
| Retrospective | 0 | 0 | 2 | 1 |
| Confirmation check | 20 | 39 | 59 | 33 |
| Repetition | 5 | 10 | 1 | 1 |
| Language | 0 | 0 | 0 | 0 |
| Procedural | 3 | 6 | 4 | 2 |
| Personal Addresses | 0 | 0 | 0 | 0 |
| Indirect | 1 | 2 | 6 | 4 |

Table 12. Frequencies and percentages of question types

Unlike in the EFL lecture, where all of the confirmation checks are defined by “okeys” and no answer whatsoever on the part of the students maybe because time is not provided, the L1 classroom presents a wider variety of these strategies apart from “right” and “ok”, still being the most recurrent ones.

(28) Teacher: Now you have Z you may call this Z-one then you have Z-two whatever different values, until, something happens, look, until you hit? B, **right?** up until that point these contour lines look square, **agreed?** what happens after you hit B?

(29) Teacher: As you go farther out however then you're asking what is the probability that the point falls in this region of the rack? **you see that?** then you look at rem- the Z is out here, then that's_ the area th- of that region is Z-B.

(30) Teacher: the C-D-F has to reach one and you hafta show when it reaches one. **You see what I mean?**
Student: no I don't understand the probability for the X, variable.

These confirmation checks are still similar to the ones appearing in the present corpus so far (as illustrated by “right?” in Example 28), that is, even though they seem to look for a confirmation from the students, there is no waiting time to obtain any student reaction and are immediately followed by more teacher discourse. However, these expressions do not seem to be vague words anymore, and may not play the role of fillers either. Instead, they approach and delve into students´ comprehension. Therefore, they may have a greater impact on the students´ attention and processing skills. These are entire clauses, which mean that learners´ mind will not cut them out of the speech as if they were dysfluencies. In fact, they address learners to somehow let them know that if they do not understand anything, they should state so anytime. That is precisely what happens in Example 31, where after the teacher explains the proceedings to solve a physics problem and ends his point asking about students´ comprehension by means of a confirmation check, he obtains a reaction for a student that needs further explanation.

Following in frequency within the L1 lesson are self-answered questions (27%), which do not disclose new functions apart from the ones encountered in previously analyzed lectures. First of all, the work as guidance tools to assist the speaker structure the unfolding discourse and figure out a way to proceed

(Example 31). Second of all, they function as topicalisers (Example 32), introducing new concepts or ideas.

(31) Teacher: and **which cycle times am i referring to?** well single-command cycle time and dual-command cycle time.

(32) Teacher: so, **what's left?** the four parameters rack height rack length, and the travel speed of the S-R machine in two directions. well, let's first break this down...

With a lower frequency rate (23%) but still being highly productive in the L1 lecture comes display questions. Most of the teacher discourse and the class activities are articulated by this type of question. They are produced to check students´ knowledge on the topic being dealt with, but also on-the-spur problem-solving tasks that are teacher-led, but developed by means of learners´ participation, interaction and elicited responses. As a consequence, it could be stated that this lecture is closely associated with the L1 physics class in that there is new content that challenges students´ learning and thinking skills. Although there are no instances of rising intonation replies from students signalling uncertainty, there is a high number of display questions to which no verbal output is rendered. The following excerpts exemplify the findings:

(33) Teacher: if i derive the expected single-command travel time for this rack, i'm gonna argue it's the same value for that rack. **Why is that? *<PAUSE:08>*** a lot of people are doing this, sign language. Well, it's symmetry, right?

(34) Teacher: **what stops you from uh doing the integration there?** ***<PAUSE:07>*** the max operator, right? what's a standard trick? there're d- different approaches now, from this point on but a standard trick, is to do **what? how can you get rid of that max operator?**
***<PAUSE:11>***
Teacher: no volunteers? <*PAUSE:06*> this is a pretty standard trick that's why i wanted you to think back to your bag of tricks and, recall that one...

Interestingly enough, in Example 33 there is no verbal output from the students, but as noted by the teacher, there is sign language. This fact makes it hard to know whether the students are lost for words because they cannot find the appropriate way to express themselves correctly or whether the sign language being performed is some shoulders shrugging meaning that they do not know the actual answer. Since this is the L1 lecture, the second hypothesis could be

more certain; thus, showing content hardship but ruling out any language obstacle. Nevertheless, there is no clear convincing evidence that could defend one theory over the other. Example 34 is also relevant in that in spite of the long chain of questions that the teacher offers from his second display question on trying to elicit some responses from the students, there are no attempts. The performance of this instructor contrasts with the one by the teacher of physics. It should be highlighted that while in the physics discourse all the reformulation produced by the teacher led to the students providing the final correct answer, in the engineering session, even though the reformulation and elicitation is more abundant than in physics, it is the teacher answering himself. Consequently, in physics, the students pave the way for the negotiation of meaning with their responses since an exchange between teacher-learner is possible. This negotiation is not feasible in the engineering class because there is no verbal contribution by the students.

As far as the EFL engineering lesson is concerned, referential questions are the second most recurrent type with a rate of 19%, being more frequent than display questions (12%) against all expectations. Although this fact may lead to the conclusion that this lecture allowed for somehow more involved, longer and more complex answers from the students, unfortunately, it does not seem to be the case for several reasons. First of all, some of these referential questions were closed; thus, only offering the students the possibility of answering “yes” and “no”. Second of all, the majority of the referential questions posed by the teacher were of the following kind:

(35) Teacher: Some question about the theory that we saw yesterday?

(36) Teacher: Are there more questions?

These inquiries could lead to an extended discourse on the part of the student; however, it seems that learners did not have any doubts or questions because no output was produced. Thirdly, the comments provided as result of referential questions do not follow expectations in that they are similar to the answers uttered to display questions. Table 13 below provides some evidence.

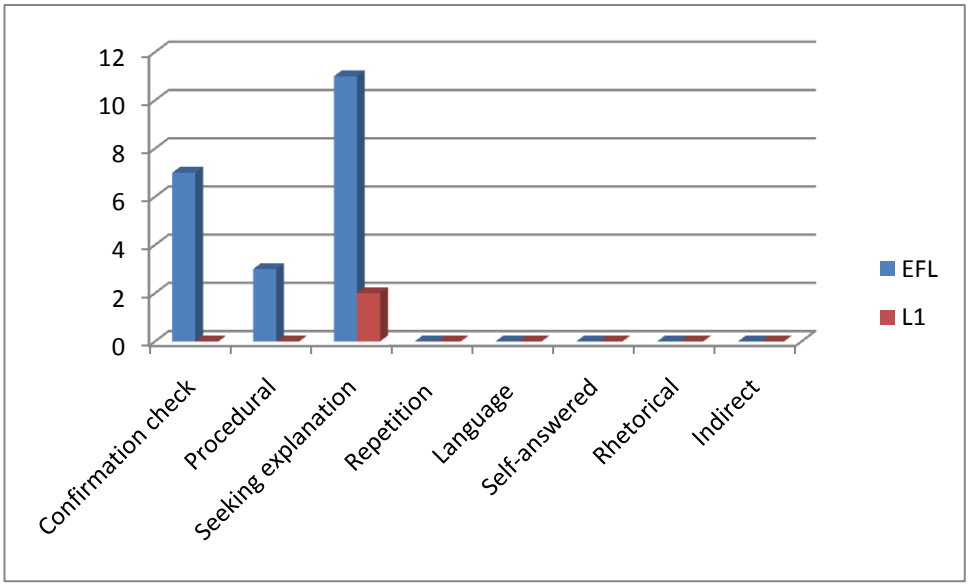
| Display Questions in EFL lesson | Referential Questions in EFL lesson |
|---|---|
| Teacher: How could you reduce the temperature? | Teacher: What do you think about the regulation in this situation? |
| Student: a cooling system | Student: It is forbidden |
| Teacher: We have to increase or decrease the density? | Teacher: Any questions |
| Teacher: We have to increase or decrease the density? | Student: What do you have to multiply it by? |
| Student: I can answer but I cannot explain why | Teacher: You have to multiply by 1.13 perhaps, around 600 horse powers or that. |

Table 13. Display vs. Referential questions in the engineering EFL lecture

As it can been seen from Table 13, responses to referential questions do not differ significantly from the ones replying to display questions. Both are characterized by being short clauses with a very limited number of words and simple grammar. As a result, although this EFL lesson presents a higher number of referential questions, results do not deviate from those analyzed so far, that is, students still have little space for engaging in extended discourse and for producing more involved and authentic oral contributions.

### 4.3.6. Engineering EFL and L1 lectures: student-initiated questions

According to students´ oral performance, in the EFL lecture 21 questions out of 72 are learner-initiated; whereas in the L1 lesson, which contains a total of 179 questions, only 2 are asked by students.




Graph 12. Comparison between engineering EFL and L1 student-initiated questions

As displayed in the graph above, the EFL lecture is the most interactive one in terms of student oral interventions. Their aims when using the language in the form of questions were seeking explanations about engineering content (53%), followed by confirmation checks that supported their ideas or assumptions (33%) and solving some procedural doubts (14%).

In contrast, the two questions asked by L1 students in their engineering lesson requested explanations, as can be observed from Table 14.

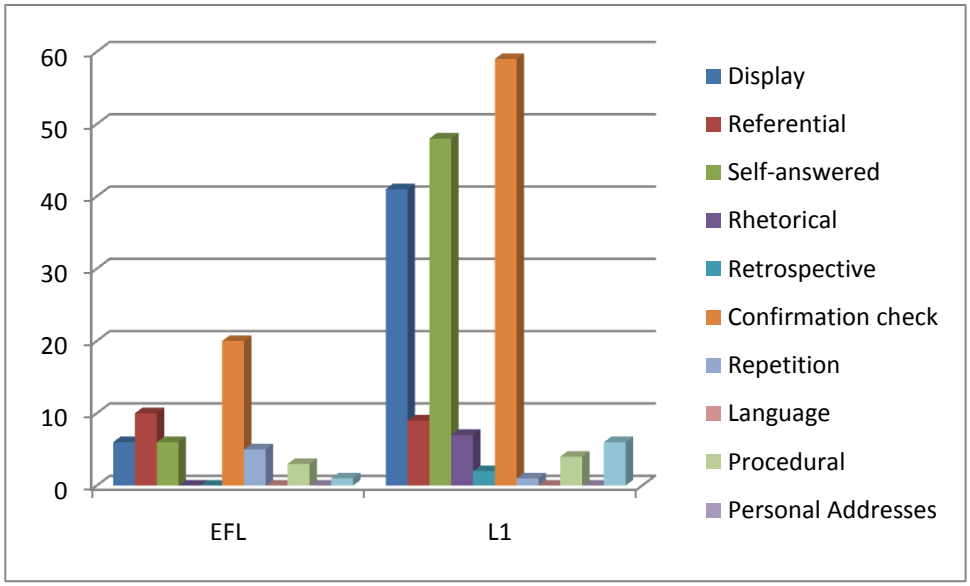
| Question types | EFL | | L1 | |
|---|---|---|---|---|
| | (n = 21) | % | (n = 2) | % |
| Confirmation check | 7 | 33 | 0 | 0 |
| Repetition | 0 | 0 | 0 | 0 |
| Language | 0 | 0 | 0 | 0 |
| Procedural | 3 | 14 | 0 | 0 |
| Seeking explanation | 11 | 53 | 2 | 100 |
| Self-answered | 0 | 0 | 0 | 0 |
| Rhetorical | 0 | 0 | 0 | 0 |
| Indirect | 0 | 0 | 0 | 0 |

Table 14. Frequencies and percentages of question types

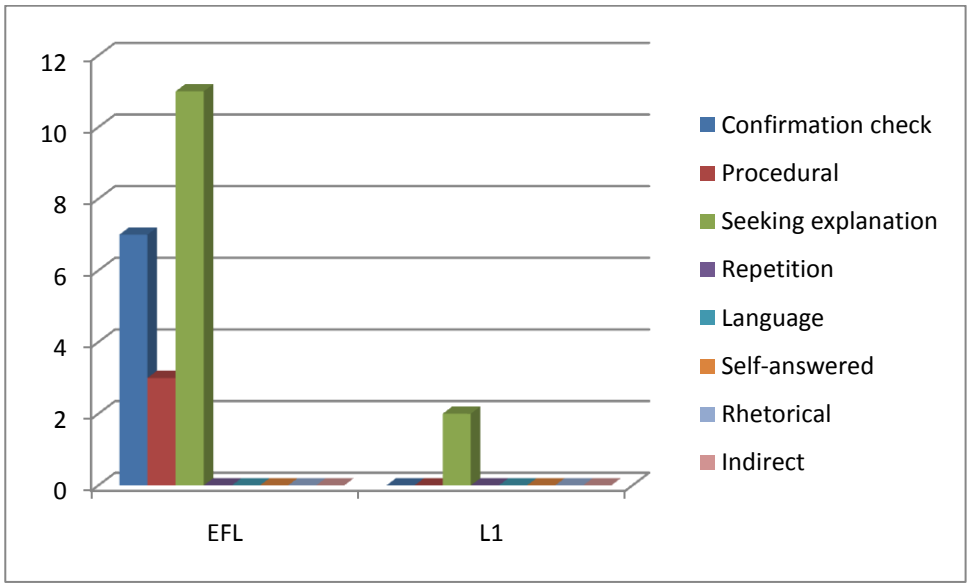
Strikingly enough, although the L1 lecture presents the highest number of total questions (179) taking into account both teacher´s and students´, as opposed to a sum total of 72 questions pertaining to the EFL lesson, the latter turns out to be the most interactive one with 38 questions triggering interaction, while only 18 questions succeed in promoting exchanges between participants in the L1 class.

These findings are in accord with the fact that a classroom is a social event in which the equal participation of the two parties (teacher and students) is required and complements one another. Thus, while in the L1 lecture the teacher addresses students very often (even though many questions do not trigger any responses), students´ needs may be met with those questions along with the teacher´s explanations encoded in self-answered and confirmation checks. Consequently, students do not seem to need to ask so many questions.

A similar situation happens to occur in the EFL lecture. Since the teacher does not address students frequently and his speech does not seem to be so rich, meaningful and helpful for the students in terms of discourse guidance questions and topicalisers that signal new ideas (as concluded by the number of inquiries taking place), students complement the lecture by asking questions and disclosing doubts that if not expressed directly to the teacher may be left unsolved. Therefore, the patterns in student-initiated questions are totally reversed in students´ behaviour in questions, as it also happened between the two business lectures. Graphs 13 and 14 provide a clearer image of this reversed pattern since they allow a comparison between teacher and student-initiated questions.




Graph 13. Comparison between engineering EFL and L1 teacher-initiated questions




Graph 14. Comparison between engineering EFL and L1 student-initiated questions

As observed from the two graphs above, the more questions asked by the teachers, the less contributions on the part of the students and vice versa.

The results obtained in terms of student-initiated questions in the engineering lectures are also a reflection and a consequence of the type of activities carried out in the classrooms. While the EFL session seems to be

solving real life engineering situations by means of computers or some kind of digital aid, the L1 lesson evolves around problem-solving tasks that are more based on mathematical operations. Therefore, while the former may promote more questions and suggestions from the students on how to solve those real life situations, the latter focuses on the teacher asking students for maths results and numerical data, which seems to be more concrete, restricted and not as creative as the EFL scenario. Some extracts illustrating the aforementioned events are the following:

(37) EFL lecture:

Teacher: The heat transfer is high. This is the normal situation in a working engine. Then the engine is very hot and we can (...) and we have to avoid the heat transfer towards the intake region. If the temperature of the air increase then we have a lower density in the…the veil or the intake base. Then, we have to reduce this term of the equation and the only way is to convert in negligible the heat transfer. It' s a problem because this part is nearly perhaps we have here around 800 Celsius degrees in this part, perhaps, in the exhaust if we have a flame just in the exhaust force, we can have even more higher temperatures, perhaps around 1000 Celsius degrees. Another situation (...) This is the engine cold (...) **Then, the situation is good or bad? For the volumetric efficiency?** Try to answer. **What is the good situation, to have a high temperature or a low temperature in the inlet pipes? Some ideas?**

(38) L1 Lecture:

Teacher: if you said B equals to one, **is this minimized...?** if you said B equals to one this is one-point-three-three-three. *<PAUSE WHILE WRITING>* **is that the uh minimum value...? what is the minimum value...?**

Student 1**:** one

Student 2: zero

Another feature that is worth mentioning in relation to the EFL lecture is peer negotiation of meaning and replying to other classmates´ questions before the teacher.

(39) Teacher: 900, ok, possible. I don' t know. I use…I've always used the kilowatts and if, I'm not to use the horsepower you can do the change easy. Ok?

Student 1: Thanks

Teacher: Thank you. Yes… *(T realizes he's got another question)*

**Student 2 asks a question**

***(And S1 answers S2. T reinforces S2' s explanation)***

Teacher: Yes, you have to multiply in the other side of the equation by the mechanical efficiency.

With peer interventions and opinions as happens in the previous excerpt from the EFL engineering lecture, discourse becomes more substantial and enriching, which also is extrapolated to the learning process itself and interaction grows more powerful. Likewise, motivation increases leading to better results in both content and language.

# 5. CONCLUSIONS

## 5.1. Summary of main findings

The present study has aimed at providing an account of questions as strategies that promote interaction and provide students with opportunities to engage in extended discourse and teachers with strategies that facilitate the delivery of subject content. As evidenced by the corpus analyzed, on the one hand, the question types most recurrently used by teachers are display questions, confirmation checks and self-answered questions. On the other hand, students usually ask questions that pursue explanations and confirmations, and to a lesser extent questions that seek clarification on procedural matters. However, even though the aforesaid question types seem to be the most representative ones in the present corpus, their distribution and functionality look quite heterogenous and vary from lecture to lecture.

After an individual look at lectures, it could be stated that questions manifest differently depending on whether the status of the language of instruction is a first language or a foreign language. First of all, there is a clear distinction in relation to cultural differences. While US lectures seem to be articulated by questions that work as points of departures of topics and deployment tools for unfolding the discourse, Spanish lectures seem to be based on teachers´ monologues and explanations.

Apart from this, the use of questions has revealed that although learning through a foreign language does not constitute a hindrance for EFL classroom participants, they have more assorted needs than apparently L1 students and teachers. Teachers lecturing in L1 classrooms use display questions and confirmation checks as the top question types. Therefore, it seems they concentrate on the understanding of content on the part of their students. However, EFL lecturers use confirmation checks and self-answered questions to assist themselves in the delivery of content as well as to ease students´ reception and comprehension of content. Consequently, even though there is no explicit focus on language in EFL lectures, the use and functions of questions in the development of the classes may indicate that attention is paid

to both aspects: language and content, as opposed to L1 teachers, who seem to be exclusively devoted to subject contents.

As far as student questions are concerned, they seem to disclose similar behaviors. L1 students produce questions seeking confirmations and further explanations, but their EFL counterparts double the number of questions asked and offer a more diverse myriad of purposes. They not only aim at obtaining more explanations and confirmations, but also need procedural clarifications, request repetitions of ideas and sometimes need language support.

During the analysis, another salient feature was found when examining question types across disciplines. When it comes to teachers´ questions, a general pattern is hinted. It seems that there is a common macro-structure shared by all disciplines possibly for the nature of lectures as such. This means that the same categories of questions tend to be uttered by the instructors of the three disciplines, only varying their number of instances in each lesson. The pattern is not followed as regards students´ responses. The only common characteristic is that in all the lectures questions seeking explanations, confirmations and procedural clarifications appear as the most pervasive inquiries.

Another interesting point emerging from analysis is that not all questions produced by teachers foster verbal exchanges. As a consequence, the number of questions is not a direct indicator of the interaction taking place in a classroom. Generally speaking, a correlation has been found in which the lectures containing the higher number of questions are also the lessons in which there are more instances of interaction. That is the case of the business and physics lectures, but not of the engineering classes.

Further insights about the use and function of questions have come from the present research paper. The comparison between teacher´s and students´ questions within the same lecture indicate that patterns are reversed. When questions coming from the teachers happen with low frequency, students´ inquiries tend to be very numerous. Likewise, if teachers ask a wide range of questions, students´ interventions are scarce. Therefore, it seems that teacher and student performances as regards questions complement each other. And

what is more, this reversed pattern may disclose the real importance of questioning in lectures, since it seems that when the functions of easing and facilitating understanding on the part of the teacher are not fulfilled, students produce questions to achieve those purposes themselves.

### 5.2. Outcomes and implications

This paper and, consequently, the results derived from it, may offer an interesting outcome for teachers at tertiary level in terms of the type of questions that could be employed to encourage students and assist them in the learning and understanding of content subjects and in the acquisition of a foreign language. Likewise, it may help content lecturers realize the importance of language as a tool and may use the present paper as a guide to refine their use of teaching strategies as such questions.

However, the results should be interpreted with caution and never may they be generalized since the study has dealt with a limited-size corpus. For this reason, further research should be carried out concerning the ways in which teachers use questions in lectures so that additional and new conclusions can be drawn.

As for future implications of the study, further ways showing interaction in lectures may be examined alongside questions; thus, enlarging the picture of interactional strategies. In addition, a more exhaustive analysis of interaction will be pursued by trying to segment the stream of speech into unit of analysis. This division may offer a clearer image of the goal of the activity mediated through discourse and may also overcome a problematic issue encountered in the data: the multifunctionality of questions. As a result, the relation between the illocutionary act by the lecturer and its perlocutionary act may be more easily discerned.

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# APPENDICES

## 6.1. Analysis Sample of the EFL Business lecture

Ok, last, last part (recording cut) … in the future´s markets alone, in an island. It was very strange, really funny. But it happened, **<<CON>>** ok? **<<CON>>** Any economic variable, anything happening in one particular part of the world will impact immediately the rest of the world and the financial markets, and the economy. So, no country but Cuba is isolated right now, **<<CON>>** ok? **<<CON>>** Mmmm the economy is global and many firms, in fact, are multinational, are growing global. Some of the most important Spanish things, Spanish firms, are currently, nowadays let us say Telefonica, let us say Grupo Santander, let us say…, there are a lot.

Ok, so that´s why we must talk about the internationalization or the firm or the globalization of the firm. So, let us start defining what´s a multinational firm (pause) which is a firm which operates in many countries (long pause) with a global perspective, I mean, trying to maximize the value of the whole global company (pause) not trying to maximize the value of one particular company in one particular country. So, yeah, normally multinational firms are in fact multinational groups.

[STUDENT: but usually **<<SE>>** aren't, aren't they based on a country? **<<SE>>**]

Yeah, they can be. The headquarters can be placed //

[STUDENT: they are…]

The headquarters can be placed in a particular country, but the globalization of the value, the, the maximization of the value happens globally. I mean, we want to generate as much as we can in a global basis. Mmm, **<<DIS>>** what happens if we obtain our benefits in the great **<<DIS>>** XXX (2´56´´)

[STUDENT: But, but it´s about obtaining value in all of the countries, but to obtain value in a whole group. So you have to lose value in someone, in some countries in order to//]

You will. That´s the point. That´s the point. You won´t matter to lose money in some particular countries because, for instance, in that particular country you pay less taxes or because you want. I mean, you want to generate jobs, you want to generate employment in that particular countries, so you are ready to lose a bit of value. It doesn't matter, **<<CON>>** ok? **<<CON>>** For your shareholders.

[STUDENT: **<<SE>>** what about the workers on those countries that lose money? **<<SE>>**]

**<<REP>>** Eh? **<<REP>>**

[STUDENT: **<<SE>>** what about the countries, the workers on those countries that lose money? **<<SE>>**]

No, the workers of those countries don't lose money. They earn money, but it´s the company, let´s say, imagine, ah.. Telefonica Germany, for instance, or O2 Germany, which is an acronym in Germany, or O2 ehh, you know that Telefonica bought O2 and O2 operates in Britain, Germany and so on, **<<CON>>** ok? **<<CON>>** Imagine, they are losing money. **<<SA>>** Why? **<<SA>>** Because if they lose money in Germany, they make a bigger profit in Britain, for instance. Ok, it doesn't matter. The German workers are paid, no problem about that, and so on. I mean, for instance, imagine, there is an activity, the research and development. It is carried out in one particular country. It can lead you, it could lead you to have losses, **<<CON>>** ok? **<<CON>>** No problem with that in that particular country, but in the global… When considering it global, you will make more profit. **<<CON>>** Do you know what I mean? **<<CON>>** Or if you, if you take this to all of the countries, to all of your subsidiaries, however you want. But the point is that you are trying to maximize the value on a global basis, considering everything, **<<CON>>** ok? **<<CON>>** So, that´s it. A global project of maximizing value.

**<<TOP>>** Which features distinguish a multinational company from a local company? **<<TOP>>** Normally we will call, we won´t say a national company. We will say a local company, a regional company. Regional is something like European Union (pause) because we are talking about economic regions, not about Catalonia, not about Murcia, **<<CON>>** ok? **<<CON>>** So, we would say a local company, a regional company, a multinational company or a global.

[STUDENT: I would understand a multinational company a company that operates solely in the UK because those are many nations and multinational]

It should be discussed. It should be discussed. Mmmmm. It is multinational but (interrupted by student´s comment), but just a little, not as much as. Yeah, of course you are a multinational. **<<SA>>** Is the Corte Ingles a multinational company? **<<SA>>** Well, they are operating here in Spain and in Portugal. Yeah, multinational. Somehow, yeah, but look, let´s talk about Banco Santander. **<<SA>>** Where do they operate? **<<SA>>** Spain, Britain, I don't know in Italy, States, then in every American country or nearly in every American country. I mean, it´s not that they make some operations there, no, it´s that, in fact, well, they are settled there, they own banks there. So in the end, they are more multinational. And **<<RHET>>** what happens if we talk about IBM or about Zara? **<<RHET>>** So, being multinational is just a matter of degree. **<<SA>>** Will we call El Corte Ingles a multinational company? **<<SA>>** We could but let us say that 95% percent of the income of El Corte Ingles are Spain based? So… yeah.

[STUDENT: but then, is it the same like, I understand that, it´s not the same a company that is settled somewhere else than a company who works for people abroad. I mean, like El Corte Ingles, they are settled in Spain and they don't have offices out there, but my brother works in XX development for them and I think they work for people out of here. I mean, they do it here, but if you are offering your product or services to whoever in England or to Google or to whoever, **<<SE>>** are you multinational? **<<SE>>**]

6.2. Analysis Sample of the L1 Business lecture

**S1:** so, [SU-m: (xx) ] (we we) [SU-m: (xx) (xx) ] (good,) like, points of view here that say yeah they're they're a crucial motivator. **<<PA>>** Emily? **<<PA>>**

**S34:** um, i think it really depen- depends on the individual because i know for me, um, i like to learn just to learn and [S1: uhuh ] i get pleasure out of that, and so when there's grades and, that puts a lot of um, it puts a lot of pressure that i don't need and i think it detracts from learning sometimes, so i think it really depends on whether you're, already a very motivated individual, or whether you need, like external motivation.

**S1:** mhm. so, you've just suggested that there are, **<<RET>>** remember back to the uh, second class? **<<RET>>** individual differences in how we're going to react to the exact same, type of motivation. **<<REF>>** other thoughts about this? **<<REF>>** **<<PA>>** Dan? **<<PA>>**

**S35:** um i think grades are definitely a motivator, but i don't know that they motivate, towards the right behavior

**S1:** **<<CLA>>** like what? **<<CLA>>** (Kim) [SU-m: yeah ] **<<REF>>** any thoughts about? **<<REF>>**

**S35:** well i think there's, um it's definitely possible to m- with so much emphasis on grades you can motivate yourself to do something to get a grade without, actually learning, which is what the grade is supposed to make you do.

**S1:** so, [SU-m: focusing (xx) ] it's called_ **<<DIS>>** does anyone, know what that's called? **<<DIS>>** **<<PA>>** Tariq? **<<PA>>**

**S5:** rewarding A while hoping for B

**S1:** yeah so we have the folly going on there and then there's also, there's another term that was used in your reading **<<SA>>** anyone, have any thoughts about that? **<<SA>>** there's something that they they talk about goal displacement **<<CON>>** right? **<<CON>>** that the grade is there to try and reinforce, try and motivate a certain type of behavior and instead of, learning the

stuff what you're really, reinforcing is getting the grade. that the grade is there to motivate a certain type of behavior. other thoughts about this, **<<REF>>** how you feel? **<<REF>>** **<<PA>>** Kelly? **<<PA>>**

**S6:** i think sometimes the grade is too like it may, [S1: just speak up. ] oh, i think [S1: (xx) ] sometimes with grades it may, influence the way you think about a class like, if you're sitting in lecture and you really enjoy the class but you take the first exam and you get a C or a D on it, [S1: uhuh ] all of the sudden you hate the class and you'll never take another class in that subject again. whereas if you didn't have the grade you may be more apt to say well i really enjoy the material, i'll sit and listen, (to some) more

**S1:** so, then, there's taking what, Emily said one step further which is it's not just that it distracts you when you're doing it but like if you really love it and then you get a bad grade, [S6: it discourages you. ] your attitude changes. **<<PA>>** Beth? **<<PA>>**

**S33:** i don't think that, the, grades necessarily reflect, learning, either like i don't think they're a good reflection. in classes where i've gotten you know like a a B-minus or something i feel like i've learned far, more over the course of the class than perhaps something where i went in with, knowledge already and just could ace the exam without even, listening, i don't feel like i learned anything in that class so, i don't know as i should be rewarded, i [S1: mm ] mean yeah i knew the material but **<<SA>>** did i really learn anything? **<<SA>>** no.

**S1:** mhm so who n- so grade_ it's not clear what grades are necessarily rewarding or even motivating **<<PA>>** Rich? **<<PA>>**

**S36:** i think that a concrete example of this like goal displacement thing is that, like you look at someone's G-P-A, the concept of a G-P-A presupposes that all classes are created equal, but what you have at Michigan especially is that people actively seek out the absolute easiest classes in the school, *<SS: LAUGH>* because they know they'll get an A in those classes, and th- n- and in doing so they they're removing you know the challenges away from their

academic experience and i think that's at the sense where, grades just you know, ruin things.

**S1:** so wait a second. how'd all of you, end up, here at the Business School where_ **<<REF>>** how do we treat grades here at the Business School? **<<REF>>** *<SS: LAUGH>*[SU-m: well ] i'm no, i'm, it's

**S4:** well if you look_ even if you wanna get into the Business School for example i mean this is a lotta the times the way they do it they padded their G-P-A with, you know

**SU-m:** (well)

**SS:** (xx)

**S1:** go ahead... go on. **<<PA>>** Jason? **<<PA>>**

**S37:** if you talk to like the admissions people like that's not what they say they say that, they look for the people that take the strong classes and i know for myself that, that's not true cuz i, barely took any, easy classes i took maybe, one easy class that's considered an easy class and, i didn't get all As and, uh like i, did poorly in a lot of classes but, [S1: mhm ] i was still_ i still got in here just because i took, a hard schedule.

**S1:** mhm, so it's schedule grades, **<<REF>>** other things? **<<REF>> <<PA>>** David? **<<PA>>**

**S24:** uh, mine was, more of the, the improper motivation because all through_ like even for a test, you studied very hard but then like often right after the test, i mean, next coupla days i won't even know the information that (xx) *<SS: LAUGH>* it's totally gone out of my life.

6.3. Analysis Sample of the EFL Physics lecture

T. **<<SA>>** What is the grain? **<<SA>>** A grain is a specific orientation that (let me get a piece of chalk)…Okay (writes on B/B) crystal it is just a regular structure, **<<CON>>** okay? **<<CON>>** Like imagine a cube of crystal we have all the atoms in the cubic positions. If I have a whole piece of material like this one in which I maintain the same crystallographic structure, okay, and just have that this is the plane, pole 01, I have…I am putting here my cube and I can have the same cube all along the structure, then what I have here is a single crystal, and I can build a single crystal if I come from the melting point very carefully, very slow and really like cooling down very very slow so I can retain the structure in just one single orientation. But, in fact, what happens most of the time is that I am maintaining not one single crystal but when I am coming down from the melting point and I am solidifying my material, what I have it is not just this orientation but I have many different nucleation points, and these nucleation points start to solidify in several directions. So I can start, for instance, (illustrates on B/B) that here it is solidifying in this direction, here in this other one, here in this another one, so I have like nucleation points and then we'll come at the end they will be solid, they will be joined together and they will have different shapes, each one of them with a different crystallographic orientation, but all that together, of course I don't have some voids or some poles in the middle of my material, and each one of them has a different crystallographic orientation. So, any one of these elements they are called the grains of my polycrystal.

S: Yes, but on the other hand you are considering the sliding planes…

T: Yes

S: They have nothing with this structure you are talking you cannot find cool a plane for the cool…

T: (going back to a previous slide)

T: Exactly, this is what happens here. **<<RET>>** You remember this image? **<<RET>>** In this image we have started to deform our polycrystal, and the primary slip plane, the one with the lowest energy, with the lowest force of dislocation starts moving it is situated in a different orientation for each one of the individual grains. So I will require my m, my Schmid factor will be a little bit different from all of them. But, at a certain point I am able to activate all of them and they will move at the beginning on the primary slip plane. In this case is like this, in this other grain, it is coming like this, in this other one, it is coming like this one.

[Another student wants to ask]

T: Yes,

S: All have the boundary . . . .

T Yes, the grain boundary is, in fact, it is giving us the geometrical factor that we have to take into account, and, in fact, in many cases what happens is that our grain boundaries they are really obstacles, they are not really moving, the boundary and I am really having this geometrical constriction, so maybe I am able to deform and my slip direction it is coming here. But, maybe, I cannot move to a certain point because I have my frain boundary. We'll see then some of the strength new mechanisms. They will really act as a dislocation barrier and…

S: XXX

T: Yeah

S: I mean and …**<<SE>>** there is some kind of bonding or there is no bonding? **<<SE>>**

T: Yes, yes,of course, we have a grain boundary, in fact we have an energy boundary. We have a boundary energy between them, and to separate the material, then you have to break this bonding energy

S: But it is…the grain, the bonding between two grain

T: It's less than the one we have…yes yes. You notice. And also it is always a distorted area. **<<RET>>** You remember that it is not a completely periodic? **<<RET>>** As we saw in the XXX we were seeing imperfections, **<<RET>>** you remember? **<<RET>>** It was a disorder area, it was a surface of disordered atoms because they are not belonging to the periodic structure. Many times they have many dislocations there, other times they have some precipitates that usually precipitate on the grain boundaries, because they are like disorder areas. **<<CON>>** Okay? **<<CON>>**

Okay, wait wait, I was saying about the grains I think I have already solved your questions

S: **<<SE>>** But the slip plane can come from one point from one boundary to another drastically or it just more…? **<<SE>>**

T: No, no no you can have high angle boundaries, and low angle boundaries, It is just depending on the orientation between these two and….

SS: No, but..

T: …and also the slip plane,

S: the slip plane

T: also the slip plane. I mean, the slip plane, you remember we saw the other day the 111 for x d sis [*sounds like some kind of formula*] or the other one for the other structures, but these are the primary ones, the ones with the lowest energy. So the lowest forces necessary to move the dislocations son those planes but the orientations they can have with respect to the other grains it can be completely random.

S: So the tailor err proficient is just…

T: an average, yeah yeah it is an average.

S: There is no formula of kind of average…

T: No I mean…

S: …at random

T: Yes, but if you consider a random with a big quantity of grains and the volume is large enough so we can really make an statistic it will give you a value close to the one observed experimentally.

Okay, so first of all we can start to see…err…what happens…err…, how we can..we can…err…stop the dislocation and if we have a certain obstacle we already saw the other day that if we bend the dislocation, then there is coming the line in tension, given by the parameter alpha, the shear modulus and the square of the burger vector. So it was possible to to calculate how much it is the XXX strength to have a dislocation, then a certain radius, **<<CON>>** okay? **<<CON>>** and it was given by this factor. It is the parameter alpha, d, v over the radius of the bent segment of the dislocation, **<<CON>>** okay? **<<CON>>** So this is just if we think that we have a segment of dislocation that is being in these two points, for instance.

6.4. Analysis Sample of the L1 Physics lecture

**S1:** **<<CON>>** alright? **<<CON>>** normally the way you would do this, is you would take this field, and send it down via some uh corner cube or something else and get it. i- i- i- in the case of optics in the case of R-F you would have two cavities, that you would be sending the atoms through and you would have to weight the cavities to, to uh, make sure that the cavities have a, fixed relative phase. so this is what's happening, and we wanna measure the population so physically, **<<SA>>** what's going on here? **<<SA>>** this is what_ you can_ once you understand that then i think uh things are are fairly straightforward. what you're doing what you're going to be measuring here, is, essentially a difference in phase. (xx)? the first pulse actually starts a clock. you can think of it as starting a clock pressing down on a s- on a stopwatch and starting a clock, and the second pulse then, stops the clock *<PAUSE:04>* **<<CON>>** alright? **<<CON>>** so **<<RHET>>** which phases are we actually comparing, with this start and stop? **<<RHET>>** if you think of this this way you won't get confused cuz a lot of times people get confused they say well look, the pulses are off we have the natural frequency here or **<<IND>>** how do we get anything in this experiment? **<<IND>>** if you think of it in terms of these clocks i think you'll, figure out what's going on. **<<DIS>>** what phases are you comparing? **<<DIS>>** *<PAUSE:06>* there's only two frequencies in the problem... aside from Doppler shift. one is the frequency of the,

**S4:** atom

**S2:** field

**S1:** well you got 'em both alright? *<S2: LAUGH>* one is the frequency of the atom [S3: atom ] and one is the frequency of the field [S3: field ] and how much frequency does the_ **<<DIS>>** how much phase does the field go through in the time interval between the pulses? **<<DIS>>**

**S2:** um... (that) length?

**S1:** uh think of it in terms of time it's easier, **<<DIS>>** how much phase does it, go through...? **<<DIS>>** its frequency is big omega, so it's just

**S4:** omega

**S3:** omega T

**S1:** omega times T, big T. and **<<DIS>>** how much phase does the atom, the dipole that you've created go through? **<<DIS>>** **<<DIS>>** if its natural frequency is little omega? **<<DIS>>**

**SS:** little omega times T

**S1:** little omega times T. so **<<DIS>>** what's the difference in phase? **<<DIS>>** [SS: delta times T ] just delta times T so all you're doing is measuring, this relative phase, of the, of the field, and the atom. the atomic oscillator. and that's what a Ramsey fringe does, the measurement does. it takes, and it lets you compare, two frequencies and this is very important because you can make f- laser frequencies very stable, and you're trying to get atomic frequencies maybe as a standard as a time standard, so this lets you, essentially get a very precise way as we'll see, of creating some type of standard, time standard. and in fact this is what's used now.

**S3:** so there's no Doppler phase

**S1:** there is a Doppler phase we have to look at it and see what's involved with a Doppler, phase. which we did that last time but i'll redo it again, today. now any question on the physics once the physics once you got the physics then the rest is, is is mathematics but it's i- it's really, a- and there are some, important applica- implications of the Doppler shift as well, so we have to look at that. alright everybody **<<REF>>** any questions on the physics? **<<REF>>** **<<CON>>** alright? **<<CON>>** stop_ start and stop of a clock, so that last time we calculated in fact what W is, right after the second pulse, and that's_ we're interested in rho two two, or W, it doesn't make a difference really. and W, is just sine A-one sine A-two and those are the areas of the pulse, E-to-the-minus-gamma-T, cosine delta-bar T, where delta-bar equals delta plus K V-perpendicular. which is K V-Z, and then there's another term, which, has cosine A-two, but doesn't depend on delta... that's just essentially the part of the ground state that went through without, getting excited, and we're not really

interested in that. so we can neglect this part, *<CROSSES OUT SOMETHING ON BOARD>* not that it's not there it'll give you some background, but it doesn't depend on delta. now remember we're gonna look at our signal as a function of delta...

**S2:** but **<<SE>>** aren't you gonna record that when you make the measurement y- **<<SE>>**

**S1:** it's a background so it affects

**S2:** so **<<SE>>** how do you get rid of it? **<<SE>>** i mean, you, have to have some

**S1:** it doesn't make a differ- in other words even if you have a background signal [S2: yeah ] that's a constant, and that's not what you're interested in, so it may affect your signal to noise, but it won't affect the the shape of the signal it'll just add, it'll add a D-C component to the signal, **<<CON>>** alright? **<<CON>>** now in fact, you can see that if you, judiciously choose A-one and A-two, you can actually make this term vanish identically, as well. alright if you take the first pulse pi over two pulse, and the second one, well i don't know if you can make them both vanish here, uh, if you take the second pulse pi over two this vanishes... so it doesn't look like you make both of these uh this is sine-squared A-one over two, so, um *<PAUSE:07><WRITING ON BOARD>* well i don't think you can make, both these vanish and that one not be uh, not be zero but if you just take, the second pulse, have an area of pi over two, then the f- this term vanishes anyway, because cosine A-two would be zero... so we have to calculate the integral of this over velocity and we need some velocity distribution, this is not in the vapor cell (now,) we have a beam, so there's some transverse distribution of velocity, due to the divergence of the beam, there you have divergence of the beam, and there's some distribution of longitudinal velocities. if we're a model energetic beam, **<<DIS>>** what would the longitudinal velocity distribution be? **<<DIS>>**

**S2:** two, **<<CON>>** you mean it'd just be constant? **<<CON>>**

**S1:** not constant if it was monoenergetic **<<SA>>** it would be a? **<<SA>>** delta function, it would be delta V-X minus whatever the, speed of the beam is, **<<CON>>** alright? **<<CON>>** monoenergetic means you have all the, atoms have the same longitudinal velocity, **<<CON>>** alright? **<<CON>>** now out of a thermal source you don't get that out of a supersonic source you can do a lot better, and you can use laser cooling techniques actually to get close to that. so let's, i just took a simple distribution, for the speed along the beam V-X-squared, typically in a thermal beam it might be V-X-cubed, times E-to-the-minus-V-X-squared just moves it out a little bit. but this is just a function that's peaked, at some value related to U-X. so we have to calculate, the <*WRITING ON BOARD*> integral, of cosine, delta plus, K V-perpendicular, times T, now remember T is, L over <*WRITING ON BOARD*> V-X, times W of V <*PAUSE:06*> now this is again related to integrals we've seen before, but, the important thing is that let's look at <*WRITING ON BOARD*> K V-perpendicular... times T. and let's take some typical values. K is on the order <*WRITING ON BOARD*> of ten-to-the-fifth centimeters-to-the-minus-one in the optical this is in the optical... <*WRITING ON BOARD*> domain. let's take a thermal beam, <*WRITING ON BOARD*> V-perpendicular let's, let's take an angular divergence, of ten-to-the-minus-three that's a pretty small angular divergence. ten-to-the-minus-three radians

**S3: <<SE>>** why they in the Doppler now they have, the exponential, um, Us, um U-X, uh, U, is that? **<<SE>>**

**S1:** this is U-X-squared. alright that's, gives us the most, that's related to the most probable, speed along the beam

**S3:** but here w- we have we have U-squared not

6.4. Analysis Sample of the EFL Engineering lecture

T: Another situation. This is the engine cold. This here is a transfer that can be problematic because we can…er…ar ..fatic? erratic? process due to the increasing of the temperature in the pipes. We can see here the engine. The first part that is going to be hot, this part and this other part, the rest is more or less cold. Up there a small time, we have this situation and when the engine is given the maximum power, the temperature is near 1000 Celsius degrees. Ok, then, remember that we have to avoid the heat transfer toward the inlet pipes and if, as designers, we manage to do that, we can erase it, can erase the term that we have with the heat transfer and the only effect that remains is this one and observe that here it is a minus thing. Then, the situation is good or bad? For the volumetric efficiency? Try to answer. What is the good situation, to have a high temperature or a low temperature in the inlet pipes? Some ideas? Any idea about this? *(pause)* You see something to say about this?

S:….

T: Try to, try to design this. We have to increase or decrease the density? Sorry?

S: …

T: Ok, we have to…The key to answer this question is to use the….*(long pause)* gas gas low. We want to increase the density, then we have to increase the pressure…OK, that! We have to reduce the temperature. Ok! And that is that, the *(high pitch)* result that we have here, because the energy that the fuel takes it goes to the liquid estate, to the grade force estate (?) to the gaseous estate. That energy reduce the temperature of the air because the only energy that the fuel has around is the energy of the air, ok? Then, the vaporisation energy reduce the temperature of the air. And we can now for petrol or for gasoline we can introduce here the value 300 Kilojules per kilogram of fuel, the specific head at pressure at constant pressure is around 1000 Jules per kg of air and Kelvin, the atmospheric temperature strikes with 300 Kelvin degrees and introduce here the value that we know. This is the stoichiometric value for the gasoline, over 1, 1 over 14.6. This is the value that we know that we have to put to

increase the speed of the plane, around 1.16 and your result is that we obtain a reduction of the temperature as we want, around 8%, okey?. Then, the result is that the injection reduce the mass of air by a 2% by increase when we are looking at the pressure, by increase the mass of air by an 8% when we are looking at the temperature. The global effect is that the injection process increase the power of the engine *(pause)* around a 6%, eh?. If you use pure injection you can obtain more or less a 6% more power because the temperature of the air is reduced by reduced by an 8%, the pressure is reduced by a 2%. The global effect is to increase the tempera- *(self-correction)* to increase the density in a 6%. We have a loss here of a 2%, an increase here of around 8%, the global effect in the volumetric efficiency is a 6%. Okey? This is the number that we. . .perhaps you have used it yet. I don't know if it' s already used here. Yes, I have…I can see here a 1.06. This is the volumetric efficiency? In this expression? This…what is this number? Ah, ok, yes, ok, the explanation for that is that the fuel needs energy to pass to the liquid estate to the gaseous estate, ok? Ok. How can increase then, because this is a theor- theoretical result and, then, we can go to the mind of an engineer that knows this information and he wants to obtain these advantages. To obtain the advantage we have to convert the liquid fuel into gaseous fuel a quick as possible. Then, to increase the vapour ratio, the velocity of the vaporisation, we have to increase the surface of the drops that we have in the injection process. The best way to do that is to increase the injection pressure and, again, the regulations have a rule here: It is forbidden to use more than 100 watts as a pressure in the injection system. We are designers. We have to choose this value, the maximum one that the regulations allow for this. What is the purpose? The purpose is to obtain the 6% increase incrementing the volumetric efficiency. Ok? Another solution for increasing the volumetric efficiency? Another…perhaps…in temperature? How can…how could you reduce the temperature?

S:….

T: What?

S:. . .

T: a cooling system, ok. Perhaps we could use a cooling system in the pipes, ok, and, perhaps, by injecting other substance? For example, …sorry,

S:

T Ok, perhaps we have to do the number, to calculate the power, that the span, as you said, is greater or not than the advantage you obtained (??? Doesn' t make sense ☹). There is other. We can, we can reduce the temperature of the air by other ways, for example, using other fuels, sorry, other liquids that can be evaporated. For example, we could make an injection of water, liquid water, because the liquid water….

(I*nterruption – sb at the door. T talks to him/her)*

because the liquid water can be to…could be in a gaseous estate and the result is the same as the fuel. Ok.

What do you think about the regulation in this situation?

S: It is forbidden…

T: It is forbidden…Yes because it is easy, yes. You are understanding the…the main idea of the regulation. The regulation has to forbid everything that is very easy to do to obtain power.

S: ….(a girl, this time)

S: Another student answers (students' interaction / discussion)

T: Yes, efficiency, efficiency. If you have the best engineers, you have the best efficiencies.

(S girl again)

T: Yes, that is…

S: (girl continues….)

T: ….no, they are not the same. They are engines. They are the best because the efficiencies of one engine are better. The best way is to increase…the best way to obtain a better engine than the competitor is to increase the…the speed

of the crankshaft, better than to increase the efficiencies, because the efficiencies are very…very complicated to improve because they are fixed by the physical laws to…

S:…

T: Yes, yes.

S:…

T: Yes

S: …

T: Yes, but…Yes, of course. But you have geometrical variables that you can improve. But there is a difference here: That the expression of the power. Wow! *(pause)* the expression of the power…in the expression of the power. I don' t know…where is it, perhaps here *(technical problems?)*

*(SS chatting)*

…here, in the expression of the power, the power is directly proportional to the speed and it is directly proportional to the efficiencies. In that way both parameters are more or less the same. We can increase the speed to obtain more power and we can increase the efficiencies to obtain more power. The difference between the engines in the Formula One racing it can be only here because the rest of parameters are fixed by the regulations. Then, if one engineer is best…is the best or is better than other engine is because it has more speed in the crankshaft or more efficiencies or both of things. But if we are the engineers that we are thinking about this, and we can to choose to increase first, the rpm, and, then, if we can, increase the efficiencies.

6.4. Analysis Sample of the L1 Engineering lecture

**S1:** that's B-squared over six... you're gonna have to be careful between the Bs and the sixes here <*PAUSE:05*> so the question is uh **<<SA>>** how do we extend this to the dual-command cycle? **<<SA>>** cuz that- that's what we wanna do. so now, to do the exact same thing for the dual-command cycle... oh before i show that i said i'm gonna come back to these, these C-D-Fs have a very nice uh_ they're just the C-D-F of the uniform but they have a very nice interpretation in the rack... here's our rack, okay, randomly pick a point, uh... X-Y or actually before i do that let's see this is B-one i wanna put my imaginary line here, **<<CON>>** okay? **<<CON>>** so it's square in time up to that point and then after that is the rest of the rack... if i ask you to connect all the, points in the rack, that have equal travel time, what would emerge is what most people call a contour line, contour line or, iso-cost line some people have called it but of course we're not talking about cost here, just substitute travel time. that means, i ask you to show me all the points, connect them remember this is a continuous rack so there are infinitely many points in it but i ask you to connect, all the points, that have equal travel time, a line will emerge we call that a contour line, **<<RHET>>** what would that line look like? **<<RHET>>** remember you're looking at, the rack in time this is not... <*VOCAL INTERRUPTION*> excuse me in feet. this is in travel time... well to do that you're gonna go up le- i think i went up Z. let's go up, directly Z time units. **<<SA>>** can i go out Z time units? so at least these two points have the same travel time agreed? **<<SA>>** well **<<SA>>** can i go to this point? **<<SA>>** sure **<<SA>>** what would be the travel time to that little point...? **<<SA>>** it's the maximum of that and that **<<DIS>>** so the travel time is? **<<DIS>>**

**S3:** Z.

**S1:** still Z. i can keep going up like that and maintain a travel time of Z, **<<SA>>** up to where...? **<<SA>>** up to that corner. cuz if i go any farther the travel time would be more than Z. likewise i can go to this point, so i'm travelling a little bit horizontally but my critical travel is still vertical travel time to that point is still Z. Z Z Z Z and by the way what you're getting is a square contour line all the, points on that line travel time to any point on that line is Z... that's called a

contour line, and, these lines will keep growing **<<CON>>** right? **<<CON>>** now you have Z you may call this Z-one then you have Z-two whatever different values, until, something happens look **<<SA>>** until you hit? **<<SA>>** B **<<CON>>** right? **<<CON>>** up until that point these contour lines look square **<<CON>>** agreed? **<<CON>>** **<<DIS>>** what happens after you hit B? **<<DIS>>** **<<DIS>>** what if i said, show me the contour line to a Z value, but, Z is greater than B? **<<DIS>>** **<<DIS>>** what is it gonna look like? **<<DIS>>** so we're in this region of the rack **<<DIS>>** what would the contour line in that region look like? **<<DIS>>**

**S6:** vertical.

**S1:** **<<REP>>** hm? **<<REP>>**

**S6:** vertical line.

**S1:** vertical line exactly. *<PAUSE:05>* okay so you have two types of contour lines and, what guess what the break point is. it says, the contour line varies depending on whether Z is less than B or Z is greater than B. **<<SA>>** guess what? **<<SA>>** here's the break point if Z is less than B you have s- one expression, if Z is greater than B you have another expression for the C-D-F. okay what if i said, given that the travel time is less than or equal to B pick a Z value pick any Z value less than or equal to B given that it's less than or equal to B, **<<SA>>** what's the probability, that a randomly selected point, will have travel time less than or equal to Z? **<<SA>>** cuz remember the C-D-F says **<<SA>>** what's the probability that that travel time is less than or equal to Z...? **<<SA>>** well randomly pick a point, the probability that the travel time is less than or equal to Z is **<<SA>>** what? **<<SA>>** is the probability that the point falls anywhere in that square **<<CON>>** do you agree? **<<CON>>** if the if the point falls anywhere within the square, then the travel time to that point is gonna be less than or equal to Z. then it's like asking **<<SA>>** what's the probability that the point i picked falls in the square? **<<SA>>** that probability is equal to the area of the square, divided by, the area of the rack. **<<SA>>** what's the area of the square? **<<SA>>** Z-squared

**S6:** Z-squared

**S1: <<DIS>>** what's the area of the rack? **<<DIS>>**

**S6:** (E.)

**S1:** B. *<PAUSE:05>* **<<CON>>** okay? **<<CON>>** and, as you go farther out however then you're asking **<<IND>>** what is the probability that the point falls in this region of the rack? **<<IND>> <<CON>>** you see that? **<<CON>>** then you look at rem- the Z is out here, then that's_ the area th- of that region is Z-B, and the area of the rack is B, Z-B divided by B **<<SA>>** gives you? **<<SA>>** Z so this is just a different interpretation, using contour lines if if you don't find this appealing that's fine i mean you don't have to, uh, follow this contour line approach what's important is that you follow this approach that is, all i all i have done is taken the two C-D-Fs multiply them, to get the C-D-F of the one-way travel time. but i show this contour line cuz it is a nice analogy, of what's happening and uh also later in the course, these contour lines are helpful in figuring out what to do how to treat racks, that have I-O points at a location other than the corner then the contour lines play a big role. yeah.

**S5: <<SE>>** how could Z be greater than one? **<<SE>>**

**S1:** oh it can't be uh most people here would have wrote uh otherwise you still have to... uh well no you can't say otherwise uh cuz well negative Z values are not allowed, uh any other region uh it's one it i- in our rack physically Z can't be greater than one. but if if you leave it like this, nothing changes for us, statisticians won't like that. the C-D-F has to reach one and you hafta show when it reaches one. **<<CON>>** you see what i mean? **<<CON>>**

**S5:** no i don't understand the probability for the X, variable.

**S1:** uh the probability for the X variable is, take a uniform variable between zero and one, and you ask yourself **<<IND>>** what is the C-D-F of a uniform? **<<IND>>** that's the C-D-F of a uniform. *<PAUSE:07>* do you know the C-D-F of a uniform distribution that's all it is.

**S5:** okay.

**S1:** and i agree with you Z greater than one does not exist well at equal one it exists, but if you leave it like this statisticians don't like that. you have to show when the C-D-F reaches one. technically when Z equals one Z itself is one so it reaches there but they wanna see that. that's redundant. if it's confusing you you can ignore it. because technically as you see when Z equals one that value take- that function takes the value one... so that's just the C-D-F of a uniform (say) forty-five degree line... and this is this is also the C-D-F of a uniform but instead of uniform between zero and one this is uniform between zero and B... **<<CON>>** okay...? **<<CON>> <<REF>>** any other questions? **<<REF>>** *<PAUSE:08>* okay well how do we extend this uh the contour lines as i said play a role with different I-O point locations... we'll see that later uh right now if you don't see why the contour line, those areas that i divided gives this expression that's okay you don't you don't have to worry about that part... now we say well what do we do with uh, i have about a little over five minutes left so i'll start this derivation and we'll continue next time. the statistical approach for expected value of travel between in a normalized rack is what we want. if we're gonna use the so-called statistical approach, then **<<SA>>** how do we start? **<<SA>>** get the C-D-F first **<<CON>>** right? **<<CON>>** from that get the P-D-F then integrate it and get its expected value. uh and just to avoid confusion with G, i used F-of-Z, for the uh probability, uh that, the uh travel between time, is less than or equal to Z so this is the C-D-F, of the travel between time that's how you start out. that is equal to the uh probability that, the uh maximum, of X-one minus X-two absolute values and Y-one minus Y-two absolute values is less than or equal to Z, use the same trick the max- probably that the maximum of those two is less than or equal to Z is equal to the multiplication of the probability so i'll skip that trick, and what you get is, this is equal to the probability that X-one minus X-two absolute value is less than or equal to Z, times the probability that Y-one minus Y-two absolute value, is less than or equal to Z. okay so i just skipped a step i hope everybody followed that.