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From Scientific English to English for Science: Determining the Perspectives and Crossing the Limits

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Abstract
This paper contributes to the didactic foundations of an epistemology of specialized English from a French perspective. Scientific English will be the content domain which will serve this purpose. While its transverse features (e.g. discourse, genre) have been widely investigated, it continues to lack a comprehensive approach to what is a multifaceted object, namely: 1) scientific content; 2) expressed in a foreign language; 3) which needs to be appropriated by student-learners. Another concept is needed. The transition from scientific English to English for science is regarded in terms of territory, domain and disciplines and from various perspectives and limits. Scientific English is envisaged as a narrow domain focused on linguistic aspects. To remain relevant, scientific English needs to be both broadened and enriched, and its scope delimited. These weaknesses lead to the design of English for science. The meta-concept of English for science has been forged to overcome these gaps, by crossing boundaries that limit an epistemological approach. It is then necessary to trace the method which consists in setting the boundaries for the new territory of language teaching and learning, which overlaps two domains – English and science – to develop a new domain – English for science –.
***Key words**:* didactics, English for science, epistemology, languages for specialists of other subjects (LANSAD), specialized languages

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1. Introduction

Compared to traditional areas such as literature, civilization or linguistics, a lack of research has meant that specialized English (*Anglais de spécialité*, ASP) has for many years lacked prestige. This changed in the 1970s when, under the leadership of Professor Perrin, a new area was developed which combined research into ASP and the didactics of language teaching. The field has seen ongoing development over the past 50 years; however it continues to suffer from a lack of epistemological foundations (Van Der Yeught, 2014).

This author argues that ASP specialists are primarily linguists who confine themselves to the language dimension of their research, but that the study of ASP should not be limited to a "historical linguistic exercise" (Van der Yeught, 2012: 17). The situation can be compared to a teacher who teaches Shakespeare's plays but does not consider Shakespeare himself and the context (cf. Van Der Yeught, 2014). Similarly, all of the dimensions of ASP have not yet been integrated into its epistemology.

This paper contributes to the didactic foundations of an epistemology of specialized English from a French perspective, in the domain of science. While the transverse features (e.g. discourse, genre) of scientific English have been widely investigated, it continues to lack a comprehensive approach to what is a multifaceted object, namely: 1) scientific content; 2) expressed in a foreign language; 3) which needs to be appropriated by student-learners. Research is carried out in the context of the wider domain known as *Langues pour Spécialistesd'Autres Disciplines* (LANSAD)/Languages for specialists of other subjects that emerged in the 1970s. While LANSAD brings together a set of teaching practices and a clear educational and scientific direction, it has so far failed to develop into an independent field of scientific research (Van der Yeught, 2014).

The research into English for science was motivated by the author's background studies in science and present position as a lecturer and researcher at a scientific university in France (Université Toulouse 3 - Paul Sabatier –UPS). Currently, scientific English at UPS is taught by teachers who have no real expertise or experience in science and/or the didactics of foreign languages. Their teaching approach mainly relies on the Anglo-Saxon tradition of English for Specific Purposes (ESP) which is purposive rather than focused on specialized domains: the emphasis is on language objectives, while professional and disciplinary objectives are either ignored orjuxtaposed without any real articulation with language. However, as it is clear that linguistic objectives are important and that teaching scientific English(Crosnier, 2015) is essential, some teachers draw upon the ASP concept as it combines linguistics with the cultural dimensions of language (cf. the concept of "langue-culture"[i]).

In developing the meta-concept[ii] of English for science, ASP researchers need to constantly cross or eventransgress limits and forge new perspectives (Rabatel, 2013). However, the process is demanding, and resistance, which can be interpreted in terms of perspectives and limits, may end in new limitations. There are two ways to overcome the problems: one is to examine the discipline itself in order to comprehend the knowledge to be explored, and the other is to take a wider, inter- or multi-disciplinary approach (Rabatel, 2013). This leads to a discussion of the 'vertical' (diachronic) dimension of ASP (Van der Yeught, 2014) by exploring other approaches focusing on science: its philosophy, history, and sociology. By weaving these

three dimensions together, and borrowing from Piaget's "internal epistemological critique" (1970), the present author develops the meta-concept of 'English for science' rather than 'scientific English'. Unlike scientific English, English for sciencecrosses , combines and articulates the cultural, linguistic and didactical dimensions of ASP (Morin, 1990). However, this dialectical process requires the construction of a framework that can overcome both the diachronic and the syntactic limits and perspectives of English for science.

2. Observations about scientific English and its context

Scientific English in its current form contains several limits that can be regarded as barriers and inconsistent perspectives. This is due to the general context of LANSAD to which scientific English belongs. LANSAD as an object is essentially limited to the definition of its elements (ASP, ESP) (§1) and determined according to institutional constraints applied to the transmission of knowledge in higher education (§2). Furthermore, scientific English has essentially been viewed from the perspective of language, while science itself should also be examined in order to identify its key elements (§3).

2.1. ASP, ESP and LANSAD: a confused domain

An analysis of the general context of language teaching for non-linguists, together with specialized languages such as ASP (with a particular focus on scientific English), ESP and didactics offers a particularly fruitful direction for understanding how LANSAD is organized.

Langue de spécialité (LSP) is a French term used to refer to specialized languages (ASP is the variant for English) and was defined by Perrin (Mémet& Petit, 2001, p.312) and Petit (2002, 2004). Following their work, the French *Société des Anglicistes de l'EnseignementSupérieur* (SAES) approved the following definition (2011), which characterizes ASP as "a discipline and the fourth branch of 'English studies' which examines these objects and develops a didactic reflection on its teaching and learning" (Mémet& Petit, 2001: 8). According to Mémet (2008, p. 27), ASPcan be studied from different perspectives: linguistics, didactics, pedagogy, civilization and culture.

Early issues of the journal *Asp*, published by the *Grouped'Etude et de RechercheenAnglais de Spécialité*(GERAS) pertaining to scientific English show that there are more pedagogical approaches than didactic reflections (with the exception of research by authors like Crosnier (1993, 1996)). The principal approach sees language solely from a linguistics approach and leaves aside other didactic and specialty perspectives. Discourse analysis (e.g. Carter&Rowley,2001, 2003;Banks, 1998, 2006[iii]) is another perspective of research that was followed with the study of genre defined by Swales (1990). Many French researchers in English studies (e.g. Sionis, 1994; Martin, 1996) are, or have been influenced by Trimble (1985)'s and Swales (1990)'s major works on scientific discourse, in particular the enunciative theory of French linguists, or research into the sciences of language[iv] (Laffont, 2005). While the transverse features (e.g. discourse, genre) of scientific English have been studied, vertical studies of the intersection between the specialized domain, science, and language have been neglected, together with the diachronic approach. This is supported by the following quote, which shows that ASP and scientific English have not been studied from all possible perspectives, "To date, LSPs have never been systematically described and their perimeters are poorly defined, some of themare constantly changing" (Van der Yeught, 2012, p. 5).

In the Anglo-Saxon tradition of specialized languages, ESP was developed for economic, scientific and technical reasons (Hutchinson & Waters, 1987) and became the dominantinternational approach. It is based on multiple purposes rather than specialized domains, which means that there is no set body of knowledge to transmit to learners. The focus is on the learner's pedagogical objectives and specific professional needs rather than language. Furthermore as Swales (1985) notes, the approach is essentially synchronic:

> ESP practitioners are concerned with the 'here' and 'now' of their own working situation; in general they do not look across to see what other people in similar situations are doing and they do not look back to see what people in their own or other situations have done(p.2).

ESP's pragmatic approach makes it an interesting pedagogy yet, as we have seen, it has limits. Nevertheless, most scientific English teaching relies on the ESP tradition, while ASP and ESP do not take the same theoretical approach to language.

There are didactic consequences for ASP/scientific English teaching related to, for example, the appropriation of knowledge by learners and efficiency. Usually, English teachers in French scientific universities teach and learn the 'object' simultaneously. Most have had no specific training in LANSAD or specialized/scientific English except during their studies and preparations for competitive examinations .Moreover, they rarely have any experience of scientific communities(industry, laboratories, education/training). Their approach frequently relies on the Anglo-Saxon ESP tradition, although if the ASP approach is used, the language dimension (language as a tool) is emphasized. From the learner's perspective, courses that are based on language as a tool do not always serve their professional objectives. Moreover, they have little motivation to learn a 'language' that they have already been learning for seven years at school. Course contents often reflect a lack of scientific knowledge. It is clear that ASP's didactic approach has not yet emerged.

The fundamental problem lies in the general context of teaching and learning languages for non-specialists, which is rarely seen as a research domain. The characteristics of teaching and learning are non-existent and hence the aim is unclear (cf. Van der Yeught, 2014). This leads to epistemological and structural problems: an absence of knowledge that can be transmitted to teachers and students, and a lack of teacher training (Van der Yeught, 2014). A didactic approach specific to ASP has not yet emerged.

LANSAD appears to be more similar to a "territory" (O'Connell, 2016) with blurred boundaries, rather than a clearly delimited domain. It has no set framework and lacks a methodological approach. Although the reasons for this situation are many and varied, a lack of institutional policy is the major one. The terms LANSAD, ASP/ LSP and their didactics are often confused, while they are in fact distinct. Two types of LANSAD course are taught: the first is designed for students with different specializations who take the same English course, but are not taught a specialized language; in the second, students with the same specialization are taught LSP. In the humanities, the first case prevails and the notion of LSP is seen as irrelevant.

Therefore, there is confusion in both the organization of LANSAD teaching and its constituent elements. This leads to a lack of perspectives and a need for specific boundaries in the definition of ASP (although it seems to be a broader domain than ESP), and in the design of ESP and LANSAD. Furthermore, in the LANSAD context, a didactic approach has rarely been taken in order to guarantee high standards in the teaching/learning process. The emphasis is on language rather than the content and the didactic approach. GERAS is the leading French research group on ASP, and one of its Special Interest Groups (ESP learning and teaching) has studied the link between ASP and didactics.

2.2. Hyper-specialization and the closure of disciplines in higher education

LANSAD, LSP/ASP and notably scientific English lack epistemological foundations. This is due to two institutional limits: the researchers' and teachers' education, and institutional recruitment; the first having an impact on the second.

The first point to note is that the English education of LANSAD researchers and teachers is focused on literature, civilization and linguistics and follows competitive exams to become teachers. Consequently, they are focused on the language dimension in their research and teaching. As Lerat (1995, p. 20-21) points out, the linguist is torn between the general functioning of language and the specialty which characterizes it. Generally the language dimension takes precedence. Second, there are few LANSAD researchers, notably in scientific English. Teachers organize their teaching based on their personal knowledge and epistemology rather than research. Those that do use research-based scientific English rarely take into account specialty or diachronic analyses, due to their resistance and reticence in tackling scientific English from other perspectives (Rabatel, 2013).

This situation, which is found in both LANSAD and academic scientific contexts, can be explained by the institutional organization of higher education research. This is inherited from Comte's positivism, which generates a number of sealed barriers.

In higher education, although other models have been proposed (Piaget, 1970), knowledge continues to be organized vertically (Magnet, 1999). This means that the knowledge organization model (*Tableau synoptique des connaissances positives*, 1907) implies a hierarchy (Hacking, 1983) that places mathematics at the top alongside other hard sciences, "Knowledge on the top of the hierarchyis, by convention, called 'positive knowledge'" (Hacking, 1983, p. 153). This rigid, hierarchical system prevents disputes over methods, but hampers the enrichment and transference of concepts. However, specialized languages in general, and specialized English in particular, are not structured in a positivist manner. Instead, they take an inter- or multi-disciplinary form that encompasses and even encroaches upon disciplines in the humanities and exact sciences. Although multi- and inter-disciplinary approaches are advocated in research and teaching programs, it is rather as an ideal than a concrete aim; they are rarely operational in reality. As Morin (1999) stresses, "the organization of knowledge I currently struggling with a fundamental conflict between the disciplinary closure and poly-disciplinary reorganization". Students should be able to use their training and knowledge to grasp the 'complexity of the real'. Given the difficultly of teaching and learning a foreign language, learning requires a focus on new problems and progress comes from crossing disciplinary limits (Cortès, 2003, p. 10). For instance, although specialized vocabulary is the most visible/taught aspect of LSP, teaching

should also encompass the syntactic and semantic relations between the language and the specialty. Moreover, the aim of LSP is to be taught, which implies the development of a didactic methodology.

This organization leads to the hyper-specialization of disciplines and hence their compartmentalization. Consequently, with a few rare exceptions syllabi are established according to the classical division between disciplines and specialties, notably between the hard sciences and humanities. It then becomes unlikely that teachers, researchers and decision-makers work together. According to Lahire[v] (2012), there are "negative effects of disciplinary confinement, hyperspecialization and a narrow form of academic professionalism". We are deprived of "elements of enrichment of one's thought"(p.322). Moreover, the established knowledge is only partial, and a clear image of the world is lacking.

It appears that when English courses are introduced in scientific universities, they are viewed as "incommensurable worlds" (Kuhn, 1962). This means that they are embedded in starkly contrasting conceptual frameworks and languages do not overlap sufficiently to permit them to interact, or exchange ideas in order to optimize teaching and research cooperation.

2.3. Science as a key domain for teaching scientific English

Scientific English is not yet a domain, discipline or a sub-discipline of ASP. We know that it is composed of two domains – language and science – that are taught as multiple, separate "disciplines" (Fourez, 1996, p. 81), e.g. chemistry, physics, or mathematics.

English studies is an academic subject with an established community specialized in the field. As Fourez and Larochelle (2004,p. 82-83) assert, academic categorizations have both advantages and drawbacks. The main advantage is that they are an interesting way to consider the world. Each category has its own powerful, scientific approach (Callon, 1989). Teaching according to discipline consists in transmitting specific ways of examining and solving a set of questions that are part of a standard heritage. However, although this point of view is specific, it is not inevitable and other approaches could have been taken. The chosen perspective is always partial and often determined socially and historically. The boundaries between disciplines are the result of the particularity of the point of view that is adopted. However, in the case of English for science, it is insufficient to merge several disciplines as they mainly consist of scholarly knowledge.

The phrase 'scientific English' contains two terms: language and science. However, the latter has received little attention in research and teaching, and merits further investigation. The problem with science primarily lies in its unclear definition, which often relies on social representations. This is not only due to the lack of teachers' and researchers' knowledge, but also to the nature of 'science' itself. Science has always been seen as hermetic and limited to specialists who are the only ones who can understand it. Non-specialist teachers are excluded by the use of standardized symbols, equations and concepts. They skim the surface, or use science as the background or pretext for the study of language as a tool. However, science is also a domain that can be apprehended through other disciplines, and this analysis argues that its many aspects should be understood. It is generally perceived through various clichés that are analyzed here.

It is often said that science can do without language. However, language is a significant, although neglected part of science (Crosland, 2006). Scientific abstraction and rhetorical concepts owe their existence to language. AsLévy-Leblond (1996) puts it "language pulls science" ("*la langue tire la science*"[vi]).

`There is another widely-shared belief that science is universal (Lévy-Leblond, 2004, p. 104). But few researchers have addressed the meaning of universality, except for some who have turned to epistemology, history and philosophy. Levy-Leblond (1996), Pestre(1996), Fourez(1996) and Soler (2009) all study science and notably the issue of its universality. Fourez and Larochelle (2004) define the term "universal". Science is universal in some aspects (Fourez, 1996). It is a form of knowledge shared between two legitimate poles: on the one hand, there are several types and models of knowledge that are location dependent; on the other hand, universality feeds into both spontaneous ideas of objectivity and the uniform effectiveness of science and technology (Dahan, 2000).

Fourez and Larochelle (2004) link the universality of science to the universality of language, "yes science is universal, so is the English language". They argue that the universality of English was due to the power of American economics and politics, rather than the language itself. "Even if science is or claims universality for itself, it is forced to make this claim in a non-universal language" (Hauge, 1996,p. 154). When English is selected as the language of science it is not a neutral decision, although the choice does not affect the status of science, either in terms of results or claims of truth. The linguistic choice has an impact on the epistemology of science. The use of English (or any other language) always draws upon its specific system of thought or culture. Thus it is impossible to assert outright that science has neither a nationality nor a language (Leduc, 1996).

Finally it is assumed that the culture of science (which does not mean the same in English and French) can be taken into account when teaching scientific English. *Culture scientifique* is the expression used in French whereas in English, 'scientific literacy' is used, which literally translates into *alphabétisationscientifique* (Nicolas, 2012). Scientific literacy is a controversial notion (Désautels, 1998,p. 16). All definitions lie between two extremes: at one end of the spectrum, it is seen as an autonomous culture, while at the other it is conceived of as an element that contributes to the action of the citizen in a real situation (Nicolas, 2012).

Language is linked to culture. In science, the language dimension is viewed as non-essential. This is not the case in humanities, which are situated in a historical and cultural background (Mocikat& Dieter, 2014).

Science is a form of knowledge that is built with a language in a culture that has specific ways of thinking and a particular world view. In general, it is relevant to study language in relation to science and to integrate these elements in thinking about English in scientific domains, which also allows us to explore other perspectives.

3. Tracing the method

LSP is a mentally constructed object (Van der Yeught, 2012,p. 12). Consequently, unlike a natural object it cannot be described from its external appearance, and instead has to be constructed and supported by theory. Thus it is necessary to set the boundaries for the new

territory of language teaching and learning, which overlaps two domains – English and science – to develop a new domain – English for science – before establishing it as a 'discipline' (Fourez, 1996,p. 81). To do so means push backing the disciplinary limits of English studies and exploring new perspectives(cf. Rabatel, 2013) in order to examine the specialty itself and to determine the boundaries of knowledge. However, this dialectical process requires the construction of a framework based on a didactic perspective that is able to encompass the limits and perspectives of English for science.

My aim here is not to annex "disciplinary territories" but rather to gather them together in order to have a clearer view of the world (Lahire, 2012, p. 325). Science is also an individual concern as science and society are linked. Rather than integrate different disciplines, the author seeks to use them to inform her own thinking.

3.1. Exploring other perspectives

Epistemology is at the crossroads of many related disciplines that are more or less closely linked (Soler, 2009). It leads us to examine disciplines that have science as an object—history, philosophy and sociology—because it can be seen from various perspectives. "An interdisciplinary approach aims to build appropriate knowledge to a situation which uses the disciplines for this purpose and does not imply any devaluation of the disciplinary knowledge it uses"(Soler, 2009, p. 14).

Epistemology is an integral part of the philosophy of science and "not a luxury of thought" (Lecourt, 2003, p. 105). Integrating the philosophy of science enables us to better understand different intellectual approaches, modes of scientific thought, and their emergence (the diachronic perspective, e.g. Baconian thought). Lecourt (2003)takes the example of the analogy, which was seen as part of a pre-scientific stage of thought and was a key element of the magicalconception of the world during the Renaissance. However, it is integral to the inventive approach, and even had a central place in scientific creation(cf.Diderot). Similarly, Lévy-Leblond (1996, p.269)questions the value of the philosophy of science for science and argued that it could provide "a meeting between philosophical reflection and scientific knowledge on a secured and marked terrain".

Epistemology can also be applied to the history of science. Here, it is necessary to explore the concept from two complementary perspectives: synchronic and diachronic(Cassin, 2013). From the synchronic perspective, the current corpus of scientific English constituted by individual researchers and national research networks (e.g. GERAS) is analyzed in order to understand its current state of development in research and education. The diachronic perspective is supported by history and aims to establish, through the study of the past, the elements that contributed to the constitution of science and the scientific ideal .In other words, it is the study of the conditions of the genesis and development of scientific knowledge. The diachronic approach examines the transitions and transfers between different languages and cultures: from Greek to Latin; interactions with Jewish and Arabic traditions; from one ancient language to a vernacular language; from one vernacular language to another; from one tradition or system to others; or from one field of knowledge and disciplinary logic to others. For Lévy-Leblond (1996, p. 23), we cannot fully benefit from the present unless we understand past eras.

Epistemology also draws upon the sociology of science in the context of interactions between science and society. This allows an examination of the influence of science on the political, economic and social organization of philosophical and religious thought and literature, together with social constraints on the development of science. In the Anglo-Saxon approach, external factors have increasingly been taken into account. One example is Bloor's "strong programs" that essentially gave rise to the field called 'science studies' or 'science, technology, and society'. One of the key points in this perspective is the analysis of controversies (e.g. *Leviathan and the Air-Pump: Hobbes, Boyle, and the Experimental Life*, Shapin and Schaffer, 1985). Here, the 'science' in question is science in the making, i.e. scientific activities rather than the established scientific corpus. The emphasis on various elements taken from the philosophy of science triggers the development of competences (i.e. sociolinguistic and pragmatic competence, Council of Europe, 2001), that are underused in the current language learning/teaching context.

3.2. Setting limits and establishing a framework

The problem then becomes one of limiting the integration of other disciplines in a way that avoids simply listing them, and developing a relevant concept. A preliminary framework needs to be designed. Introducing the philosophy and history of science implies drawing a clear limit between the field of study and others by determining what is encompassed by the concept. It should not be forgotten that the aim of English for science is teaching with regard to the definition of ASP. Therefore, a didactic perspective is necessary. Knowledge should be limited as a function of educational institutions and society, and the focus should be placed on teaching and learning aspects in this specific context.

Currently, the aim of teaching is not considered in terms of didactic[vii]when referring to ASP, and notably scientific English. However, teaching should be framed by the didactic system[viii] and not the classroom, because the topic of interest is knowledge. In the classroom, the teacher-learner relation is most visible. Empirically, this relation seems to be binary. Yet as a starting point didactic theory must posit, as a theoretical entity, a ternary relation that unites three 'objects': the teacher, the learner and knowledge. Knowledge must be introduced into the didactic relation because very little of what takes place between teacher and learners can be understood in the absence of context.

The author first looked at the pedagogical triangle of Houssaye (1988), which can be considered as a minimum study system based on the concepts of knowledge, teacher, and student. However, neither the specificities of knowledge, nor contextual elements are taken into account in this system. Another approach is required, as the main aim is the English teacher's training in LANSAD. It is difficult to grasp the teacher's knowledge in a particular context. This difficulty can be circumvented by studying it using a didactic approach that is supported by disciplines that focus on "relationships to knowledge" (Joshua, 1996, 2002). The relationship is considered from an anthropological perspective (Chevallard, 1989) as the aim is to address the relationship to knowledge not from the point of view of the subject, but in terms of knowledge itself. This emphasizes the cultural dimension and captures the effects of social environments on both the subject and knowledge, in the specific context of the teaching act (Garnier, 2003).

First, the construction of knowledge should be analyzed in terms of the relationship between the actors, the teaching and learning context, and knowledge. This is known as didactic

transposition (DT), which is a notion introduced into the didactics of mathematics by Chevallard (1985, 1991). This concept constitutes "a researcher's working tool" (Chevallard, 1992) that is able to explain the full complexity of the teaching/learning process. This is particularly important, as teaching English for science does not solely consist of knowledge (like mathematics) but knowledge associated with skills, life skills (*savoir-être*), etc. DT examines the origin of knowledge, and the mechanisms that drive the introduction of new types of knowledge in schools. It focuses on the scientific analysis of 'didactic systems', based on the assumption that the teaching object (*savoir enseigné*), normally pre-exists as scholarly knowledge (*savoir savant*), which is "a body of knowledge, not knowledge in itself". Scholarly knowledge is transformed into knowledge to be taught (*savoir à enseigner*) and then into taught knowledge(*savoir enseigné*). The aim here is to integrate the last two forms of knowledge, which constitute the interactions between the learner, the teacher and knowledge.

The history/philosophy/sociology of science approaches can contribute to courses or teacher training of, or in English for science. The target is the teachers and their teaching, as well as the learner and their learning, which implies implementing or enhancing other skills. For example, when teaching uses an Anglo-Saxon approach based on the sociology of science (and notably its controversies) more competences are identified and mobilized: the ability to argue and take a reasoned decision, or a critical approach to information and understanding of scientific knowledge.

`The disciplinary and didactic/educational issues are thought together in DT theory. Moreover, this theory provides legitimacy to the activities of English teachers and normativity (in the sense of standardization) to English for science courses in the LANSAD domain.

4.The meta-concept of English for science

As seen previously, the reorganization of scientific English knowledge not only has didactic interest but goes further: it constitutes another perspective from which to examine LSP didactics. English for science becomes a meta-concept aimed at teaching, and an operative concept in the implementation of teaching and learning systems. Theapproach is both methodological (because it is research-based) and epistemological (because it requires the construction of a set body of knowledge). Epistemology is applied to didactics (Mercier, 2008) and the meta-concept is determined through its object, objective and methodology.

4.1. Object

Unlike scientific English, which usually erases the historical and genetic circumstances of scientific discourse (Fourez, 1996) in order to make it universal (Stengers, 1987), English for science, which is neither the juxtaposition of English and science nor its sum, crosses, combines and articulates the cultural, linguistic and didactical dimensions of ASP (cf. Morin, 1990[ix]). Science is not only a matter of objectivity, but also involves the construction of scientific practice (Hacking, 1983). Studying the whole that is not present in each separate part fosters the emergence of quality. It implies the determination of features and the exploration of perspectives that have not, so far, been taken into account in scientific English.

4.2. Aim

The meta-concept aims to provide another vision of science. English for science is a cultural way of structuring a vision (Fourez&Larochelle, 2004, p. 37). First, it is necessary to understand current science teaching in order to design the concept. For this reason it draws upon research in science education that focuses on science not only as a finished product but also in action (in the form of science and technology teaching). Both comprehension and the production of science must be reintegrated into the study of science, and above all English for science courses. While science courses emphasize the production of science, English for science emphasize understanding. English for science is not limited to the scientific lexicon, and therefore it must incorporate the role of the researcher, links with the rest of the world and therefore human relations with the world. A more holistic view of science and knowledge through language/ discourse (Narcy-Combes, 2005) comes from integrating the "human and social" dimension of science in order to establish a sub-discipline of ASP (Petit, 2004, p. 7) with the aim of achieving a higher level or professionalism. Narcy-Combes (2005, p. 37-41) developed a didactic perspective of language centered on three transductive[x] relationships. The focus is no longer solely on language, but extends to components such as culture, knowledge and *parole*-discourse. This helps students, teachers and decision-makers to broaden their view of science. The construction of this meta-concept is intended to help in training teachers of English in the LANSAD domain.

4.3. Methodology

The authoroperates, as Piaget (1970) says, her own "internal epistemological critique", i.e. she questions the methods of evaluation and legitimization of the knowledge that it produces and teaches. The problem of the "foundations" (Piaget, 1970) of English for science can be examined by researchers in the ASP domain, and not only epistemologists (Lemoigne, 2003). Its scientific, philosophical and humanist approaches mean that epistemology is polysemous (Verhaeghe*et al.*, 2004, p. 1). A synthetic meaning is then drawn from thinking on the construction and management of knowledge in science in the context of its relationship with other domains of scientific thinking.

As mentioned previously, the philosophy, history and sociology of science applied within a didactic framework help to determine their most coherent and relevant articulation. The author is guided by the influence of science on language and the weight of culture on science (Pestre, 1996).

The issue of reference arises when discussing the content of teaching English for science, which cannot be determined simply by scholarly knowledge (as in mathematics). English for science is a corpus of multi-referential knowledge (Accardi, 2001). The determination of the types of knowledge in English for science is part of ongoing research.

5.Conclusion

This paper has discussed the transition from scientific English to English for science in terms of territory, domain and disciplines and from various perspectives and limits. Scientific English is envisaged as a narrow domain focused on linguistic aspects. To remain relevant, it needs to be both broadened and enriched, and its scope delimited. These weaknesses led to the design of English for science. Although the expression 'scientific English' refers to two domains,

(English and science) the latter has rarely been the subject of study. Moreover, the focus has always been on teaching and learning contexts. Yet it lacks a didactic approach. The meta-concept of English for science has been forged to overcome these gaps, by crossing boundaries that limit an epistemological approach.

Firstly, scientific boundaries must be set to the territory of English for science in order to become a domain and then a discipline in the long term. The design therefore crosses the limits of English studies and explores new perspectives, taking into account the domain of science from an inter- or multi-disciplinary perspective. This process has an impact on the contributing disciplines and domains. Indeed the impermeable limits of external disciplines (such as the history of science) can be made permeable as transductive relationships (cf. § III. 2) between language, culture, knowledge reveal common ground and modify the identity of individual disciplines. The boundaries between English for science and these domains and disciplines can be envisaged as "frontiers" (cf. *The Frontier*). This implies changes in both the disciplines and domains that participate in the encounter and thus teaching English for science and science in English. Consequently, both English for science and other established disciplines can be thought of outside the state of institutional organization of science and university, based on a particular distribution of legitimate objects of study across disciplines.

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Notes:

[i]French academics have adopted the concept of "langue-culture" that does not separate the linguistic and the cultural aspects of language.

[ii]A concept which encompasses the concept of scientific English.

[iii]For example articles in 1998 and 2006 in a diachronic perspective.

[iv]*Sciences du langage*.

[v]Referring to the human and social sciences.

[vi]Or "language sticks it tongue out at science" in reference to Einstein who stuck out his tongue instead of smiling on his 72nd birthday, because he had been smiling for photographers all day.

[vii]Which can be defined as the (historically incipient) science of knowledge diffusion and acquisition in society.

[viii]A 'didactic system' is defined as the relation to a body of knowledge that is organized in the interaction between a teacher and learners in an institutional context.

[ix]Edgar Morin advocated "complex thought"referring toPascal whosaid, "I would notknow the partswithout knowing the whole, not to know the wholewithout knowingspecificallythe parts" (Pascal, 1657,1962,120)

[x]This means that the terms cannot be separated and are to be considered as a whole (Simondon, 1989).