Communicative competences in Experimental Sciences degrees within the framework of the new European Space for Higher Education

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Abstract

The scenario for developing communicative competences in the Experimental Sciences degrees and within the new European Space for Higher Education is highly complex. This is confirmed by research reported in the White Papers on the new degrees in this subject area. Therefore, to smoothly integrate communicative and linguistic competences into future syllabi, I should first make a careful analysis of the main factors at work in the new situation. This paper seeks to provide a preliminary approach to the problem. First, I describe the academic and professional tasks that constitute the objectives of future European science degrees. This is followed by an analysis of the communicative and linguistic parameters considered essential for satisfactory attainment of these objectives. Finally, the specific skills that students must master in order to meet the demands imposed by the new framework are outlined. The results of this analysis will enable us to see how much the new situation differs from traditional university teaching. Under this new model, the development of communicative and linguistic competences will no longer be a mere adjunct to a science curriculum, but instead will become of prime importance to the academic and professional training of future scientists.

Key words: communicative competence, scientific communication, European Space for Higher Education, curriculum design, didactics.

Resumen

Las competencias comunicativas en las titulaciones del área de las Ciencias Experimentales en el marco del nuevo Espacio Europeo de Educación Superior

El nuevo Espacio Europeo de Educación Superior (EEES) destila un complejo escenario comunicativo en el área de conocimiento de las Ciencias

Experimentales. Así lo confirman los análisis documentados en los Libros Blancos para las nuevas titulaciones de este ámbito disciplinar. Por ello, parece pertinente tratar de desgranar los elementos principales de dicho escenario con la vista en una integración coherente de las competencias comunicativo-lingüísticas en los nuevos planes de estudio. En este trabajo trataré de ofrecer una primera aproximación a la cuestión. En primer lugar, esbozaré una caracterización general de las tareas académicas y profesionales que articulan los objetivos de los nuevos títulos de grado adscritos a esta área de conocimiento. A continuación, analizaré los parámetros comunicativos y lingüísticos que determinarán su adecuado cumplimiento. Finalmente, señalaré las capacidades específicas que los estudiantes deberían desarrollar para responder eficazmente a las exigencias que este nuevo marco impone. Los resultados de este análisis dejan entrever un panorama muy distinto al que emerge del modelo tradicional de las enseñanzas universitarias. En este nuevo modelo el desarrollo de las competencias comunicativo-lingüísticas deja de ser un mero complemento de la formación del científico, para ocupar un lugar relevante en su desarrollo académico y profesional.

Palabras clave: competencia comunicativa, comunicación científica, Espacio Europeo de Educación Superior, diseño curricular, didáctica.

Introduction

Of the generic competences listed in the White Papers on the new degree programmes for the European Space for Higher Education (ESHE)[1], communicative competences are given the highest rating by academics and professionals. In many cases they are also part of the specific competences called for in the different degree programmes in question. Hence, development of communicative competences is clearly a fundamental objective of university education.

The interest aroused by these competences within the ESHE can be seen in the growing number of European collaboration projects, such as COVCELL (www.covcell.org), CMC (www.cmcproject.it), GALANET (www.galanet.eu) and TALC (www.euba.sk/talc/), and in the large number of educational research and innovation articles exploring formulas for building a communicative component into the syllabi of undergraduate degree programmes. Worthy of mention in this regard are works by Millán and Argüelles (2005), Pérez-Llantada (2006), Almahano et al. (2006), García and

Troyano (2006), López and Edwards (2007), Fanizza-Scheipe and Linares (2007), Gangaram, Beijer and Hajer (2007), Fernández (2008), or Pérez-Paredes (2008). A recently published volume edited by Fortanet-Gómez and Räisänen (2008) stands out because it includes a whole collection of papers focused on ESP in European Higher Education that gathers accounts and reflections on the theories and practices of ESP pedagogy in order to meet the challenges of the Bologna Reform.

Some of the most recent publications (Robles, 2006; Castelló, 2007; Durán & Cuadrado, 2007; Ezeiza et al., 2007; González, 2007; Sanz, 2007; or Iriarte, Núñez & Felices, 2008) and the White Papers for the new ESHE degrees have focused on the development of foreign language competences rather than the competences that must be developed by students in their own language(s). For this reason, I felt that studies on the communicative language competences to be developed in the student's mother tongue were needed within the framework of the ESHE, and therefore undertook an R&D+I project with three objectives in mind[2]:

i) to identify and stratify the communicative objectives to be attained in undergraduate degree programmes in the five knowledge areas into which higher education has been divided.

ii) to make an audit of the teaching resources required (particularly those based on ICT technology) in order to adequately meet the needs detected.

iii) to develop specific contents, instruments and resources for their development within the context of the University of the Basque Country (UPV-EHU).

The project is currently under development (phases two and three). In this paper, I will describe the analytical structure applied during the first phase and then present the results obtained concerning studies in the field of the Experimental Sciences.[3]

Theoretical assumptions and analytical framework

This work is based on three general assumptions that clearly coincide with the educational approach adopted by the ESHE:

- Competences as a core objective of university education.

- Action-oriented learning model.

- Communicative capacity as a complex combination of different types of general and linguistic knowledge and skills.

These principles are based primarily on the following sources:

- The pan-European "Tuning" project (González, 2007) which has inspired the guidelines for developing the ESHE and other similar programmes in Latin America.

- The conceptual framework found in the *Common European Framework of Reference for Languages* developed by the Council of Europe in 2001.

- The explanatory model for communicative competence based on the language capacities analysis proposed by Bachman and Palmer (1996).

This is the baseline from which I (together with a research group) have built the following conceptual framework, addressing some of the ideas currently predominating in the teaching of languages for specific purposes at university level.[4]

Competence-based approach

Today's competence-based approach (Le Boterf, 2000; Barnett, 2001; Alberici & Serreri, 2005; Goñi, 2005; Navío, 2005; Fenner & Newby, 2006; Jonnaert et al., 2006; Rodríguez, 2006; Zabalza, 2006; Council of Europe, 2007; Zabala & Arnau, 2007; among others) dates back to a proposal first made in the field of language teaching in the USA in the 1980s (Richards, 2001); however, it does not seem to have exerted a greater influence elsewhere until recently (Pérez & Zayas, 2007; Lázár et al., 2008; etc). Publication of language-teaching proposals based on the *Common European Framework of Reference for Languages* (Council of Europe, 2001) together with the imminent coming into force of the ESHE seem to have awakened teaching and evaluation professionals to the potential of this approach. This new focus leads us to a teaching-learning model –despite the ambiguity of the term "competence" and the fact that it has been overly bandied about– that revolves around three widely-accepted criteria:

- The criterion of "transferability", meaning that learning should be structured round objectives that are clearly related to students' future professional careers.

- The criterion of "capacity", which places the emphasis not so much on course content, but on the effective or potential capacities that the individual must develop in order to perform effectively the professional tasks called for in his/her chosen major or career.

- The criterion of "integration", which focuses on the need to successfully combine conceptual, procedural and attitudinal learning at different (cognitive, functional, social, etc.) levels.

Although there are other equally valid proposals, one of the definitions of "competence" which best captures this three-fold essence is the one put forward in the final report of the Tuning Project. The definition reads as follows:

> A broad definition of the concept of competence might define it as including the capacities that all humans need to resolve the situations that arise in their lives effectively and autonomously. It is grounded on a deep knowledge – not only knowing what and how, but knowing how to be a person in a complex, changing and competitive world.
> Another definition suggests that competences are complex integrated capacities, in different degrees, in which education must train individuals so that they can cooperate as responsible subjects in different situations and contexts of their social and personal life, knowing how to see, do, act and enjoy properly, assessing alternatives, choosing appropriate strategies and taking responsibility for the decisions taken. (….) Competence is not an innate capacity, but instead can be developed and built up from each person's internal motivations – motivations which must be communicated to the work group. The integration of these two areas makes up the life option for the development of an individual's potential, vis-à-vis their environment, based on their interests and aspirations (González, 2007: 31-32).

In the case of the communicative language competences associated with each particular discipline, the aim should be to facilitate university students' progressive incorporation into the discourse community in which their academic and/or professional career will unfold. This, then, is the key contribution of the competence-based approach to teaching specific-purpose communication skills within the ESHE.

Action-oriented approach

This position is concomitant with the most widely-accepted interpretation of the meaning of "action-oriented learning" within the field of language teaching. It first began with Communicative Action Theory (Habermas, 1999a & 1999b), was further specified in Communication Linguistics (Gutiérrez, 2002), and –within the field of language teaching– was made operative through the Action-Oriented Approach. In the *Common European Framework of Reference for Languages*, this Approach is formulated in accordance with the following principle:

> Language use, embracing language learning, comprises the actions performed by persons who as individuals and as social agents develop a range of competences, both general and in particular communicative language competences. They draw on the competences at their disposal in various contexts under various conditions and under various constraints to engage in language activities involving language processes to produce and/or receive texts in relation to themes in specific domains, activating those strategies which seem most appropriate for carrying out the tasks to be accomplished. The monitoring of these actions by the participants leads to the reinforcement or modification of their competences. (Council of Europe, 2001: 9).

This approach highlights the fundamental challenges faced by university students regarding the communicative objectives that they must be able to meet successfully:

a) first, they must be aware of the constraints imposed by the academic and professional context on scholarly or domain-specific communication;

b) second, they must develop the necessary skills to effectively perform the functional operations underlying communication within the field in question;

c) third, they must become sufficiently autonomous to practise communicating in ways appropriate to their future discourse community; and,

d) finally, they must become sufficiently familiar with and confident in using the genres and registers of text types within their future discourse community.

Accordingly, development of domain-specific communicative language competences is primarily an "experiential" activity[6]. In this regard, universities must facilitate the process of "restructuring identity" (Ricento, 2005: 904), which students must necessarily undergo in order to become full members of the academic or professional communities to which they aspire. This involves making students capable of being self-reliant in organising more and more of their work, and also of emphasising the personal experiences and contributions that this can entail (Kohonen, 1992). Therefore, at the specific level of language learning, the idea is to facilitate progressive acquisition of forms of expert communication, present in the discourse genres appropriate to the activity in question. This means that learning to be a good professional involves learning to be a good reader and writer in the discourse genres of the field (Cassany, 2006).

Student capacities-based approach

To progress towards a stage of expert knowledge, students must develop a range of capacities. Following the proposal of Bachman and Palmer (1996), such capacities can be grouped into three categories:

a) Generic capacities which, while not specifically linguistic, nevertheless are crucial to communication. Of special importance within this group are social and personal capacities (those that contribute to the process of personal growth referred to before), and instrumental capacities (capacities related to the idiosyncratic communicative customs and practices of the discourse community in question).

b) Language capacities related to the specific socio-cultural, functional, discourse, expressive and lexical-semantic knowledge that must be acquired by students in order to perform adequately in the domain-specific language in question.

c) Strategic capacities, meaning both the set of resources that will enable students to perform with confidence in their new communicative medium, and the capacity to learn through personal experience within a context of lifelong learning.

These, then, are the key capacities that must be at the heart of programmes designed to develop communicative language competences at the university level.

Analytical framework

Given the ideas outlined in the three preceding sections, I feel that an appropriate scenario for developing communicative language competences within the ESHE must comprise at least the following:

- A functional analysis of the tasks to be undertaken by graduates in each discipline, together with a catalogue of associated competences.

- An analysis of the most relevant dimensions of the communicative component entailed by those tasks.

- An analysis of the skills, factual knowledge and attitudes which together will make students capable of delivering effective career performance.

In other words, I believe that answers must be given to the following questions:

- What are the key competences required to meet the objectives associated with domain-specific communication?

- What are the characteristics of the communicative framework arising from the set of competences to be learned?

- What capacities must students develop in order to perform within that framework with sufficient skill?

These are the three specific points that have been studied in detail in our project. In the remainder of this paper, I will present and discuss the results obtained in the field of Experimental Sciences. In line with the framework outlined in this section, this material will be presented at three levels:

- Level-1: Tasks expected of graduates in the field.

- Level-2: Characteristics of the communicative framework associated with those tasks.

- Level-3: Capacities required to meet such demands successfully.

The data discussed in the following sections are drawn from a detailed analysis of the 13 White Papers published to date for the development of new undergraduate degree programmes in the Experimental Sciences.[5]

Communicative tasks in the field of Experimental Sciences

As can be seen in Table 1, of the professional competences pinpointed as key components of new syllabi under the ESHE, the White Papers identify a large number as comprising tasks where communicative factors are crucial. Although these tasks vary widely in nature and characteristics, the most far-reaching appear to be those pertaining to the following categories:

- Tasks associated with the performance of academic and teaching activities: understanding scientific discourse; explaining scientific knowledge; presenting research projects and/or results; developing teaching materials; etc.

- Tasks pertaining to a career in business: science consultancy and advice; writing up technical innovation projects; documentation of research and development projects; quality management; etc.

- Tasks involved in scientific talks and publications: publicising scientific concepts; awareness of risks of scientific technology; participation in discussions of concern to society; museum displays; etc.

We have also documented other types of task-related communication activities such as scientific information management, compliance with regulatory and administrative protocols, legal advice, scientific appraisals/opinions, etc. Finally, to this range of competences must be added those associated with interpersonal communication. These include tasks that may prove crucial in many areas of scientific work: persuasive argumentation in decision-making processes, defending personal positions or projects before colleagues and interdisciplinary teams, clarifying doubts, etc. Therefore, these should also be taken into consideration. That is, students of science must not only be able to write and present research articles or reports; they must also know how to explain science in various situations and venues; they must be able to respond to the scientific concerns of different types of public; they must be proficient at handling regulatory and administrative documentation; they must be able to argue their positions effectively and issue precise opinions; etc.

As can be seen, the new image of scientific communication under the ESHE transcends the merely academic and has moved towards a situation where

domain-specific communicative competences are viewed in line with the range of responsibilities expected to be held by Experimental Sciences graduates making a career in research, education, business, government and non-profit enterprises.

Competence area 1: Competences associated with document management
- Writing up well-structured, well-written complex reports; etc.

Competence area 2: Competences associated with legal activities
- Legal, science and technical advisor to industry or government
- Issuing technical opinions, reports and appraisals; etc.

Competence area 3: Competences associated with government and administrative tasks
- Filling out and writing regulatory and administrative forms and documents; etc.

Competence area 4: Competences associated with academic tasks
- Explaining, both in writing and in speech, scientific phenomena, facts, concepts, principles, theories and knowledge
- Explaining, both in writing and in speech, the grounds, hypotheses, procedures, results and conclusions of research projects
- Writing and delivering a talk (with appropriate audiovisual aids) on a planned project, study or report
- Logical argumentation in problem solving; etc.

Competence area 5: Competences associated with technical tasks
- Cataloguing, evaluating and managing resources, materials, products, etc.
- Conveying, both in writing and in speech, the grounds, hypotheses, procedures, results and conclusions of research projects
- Writing up studies, reports, project proposals and technical research, development, management and production projects
- Writing up and defending experiments in projects and reports
- Making a solid defence of personal points of view based on well-grounded scientific knowledge, etc.

Competence area 6: Competences associated with science education and popular science
- Generating curiosity and interest in scientific topics
- Publicising questions concerned with scientific culture
- Spreading general knowledge of scientific facts in the news media, museums, educational contexts, etc.
- Clarifying doubts concerning the implications of scientific research results, progress and discoveries
- Participating in discussions on different ethical matters concerned with scientific progress and development in society; etc.

Competence area 7: Competences associated with public communication
- Interpreting and critically evaluating how society perceives science
- Generating curiosity about science, showing how much fun it can be
- Publicising questions concerned with scientific culture
- Designing and executing scientific or technical education and communication programmes of interest to society
- Participating in discussions on different ethical matters concerned with scientific progress and development in society

Competence area 8: Competences associated with interpersonal communication
- Fielding questions on science projects, reports, etc.
- Legal, science and technical advisor to industry or government
- Providing scientific advice concerning publicity and marketing tasks, and on the labelling and presentation of products
- Presenting own work to an interdisciplinary group of professionals or experts
- Making a solid defence of personal points of view based on well-grounded scientific knowledge

Table 1. Key domain-specific competences for communication within the Experimental Sciences (Ezeiza et al., 2007).

General configuration of the communicative framework for the Experimental Sciences

The list of competences in Table 1 results in a communicative framework that seems overly complex for comprehensive management within the new syllabi now being devised. Clearly, some sort of systematization is needed to specify the parameters characterising domain-specific communication within the field of the Experimental Sciences –a systematization that will indicate which aspects should be given priority if we wish to provide a logical, well-balanced, productive education in this field.

Variable 1: Context of communication
- Academic (among experts): universities; research centres; etc.
- Academic (educational): universities; schools; publishing; museums; science workshops; scientific games and fun experiments; etc.
- Career in business/industry: interdisciplinary work groups; commercial relations with various clients; scientific advice to businesses; etc.
- Government: communication with government agencies; technical services; mediation and inspection services; etc.
- Public communication media: newspapers; journals; magazines; web contents; publicity and awareness campaigns; etc.

Variable 2: Aim of communication
- Reporting: events of scientific importance, experiments, biographies, etc.
- Describing: objects, phenomena, processes, etc.
- Defining and delimiting: concepts, principles, laws, etc.
- Presenting: data, examples, ideas, etc.
- Explaining: situations, projects, procedures, practical cases, etc.
- Directing and guiding: giving instructions, advice; proposing; correcting; etc.
- Postulating: hypotheses, speculations, approaches; evaluations, outcomes; etc.
- Discussing: giving opinions, reasoning, drawing conclusions, counter-arguments, criticising, etc.

Variable 3: Subject of discourse
- Scientific concepts, ideas, events and theories
- History of science, scientific milestones, etc.
- Technical and scientific discoveries, progress and innovations
- Scientific controversies or subjects of public interest
- Research topics and projects
- Work or research procedures, technical and scientific apparatus, etc.
- Research results

Variable 4: Focus
- Scientific
- Technical
- Practical/applied
- Educational/lay public
- Social
- Critical

Variable 5: Mode of communication
- Public vs. Private
- Discipline-specific vs. Interdisciplinary
- Oral vs. Written
- Direct vs. Recorded
- Synchronic vs. Asynchronic
- Unidirectional vs. Interactional
- Improvised vs. Planned
- Formal vs. Informal

Table 2a. General configuration of the domain-specific communicative framework for the Experimental Sciences: variables 1-5 (Ezeiza et al., 2007).

Following the analytical guidelines suggested by the "action-oriented principle" contained in the *Common European Framework of Reference for*

Languages (Council of Europe, 2001), I have characterised the communicative needs of students in this area, according to the variables presented in Tables 2a and 2b.

Variable 6: Audience/Readers

- Experts
- Technical staff
- Administrative/Government staff
- Members of social group
- Reporters
- University, secondary or primary students
- Social groups or laymen

Variable 7: Media and support

- Academic communication tools: video-conferences, postcards, slides, posters, summaries, etc.
- Interpersonal communication tools: email, video-chat, etc.
- Teaching materials: notes, teaching units, laboratory guides, etc.
- Journals and papers
- Forms and questionnaires

Variable 8: Processes and operations involved

- Information management: choosing relevant sources, looking up, compiling, selecting, interpreting, extracting, organising, analysing data, etc.
- Bibliographic information: identifying key ideas, making outlines and summaries, direct and indirect quoting, etc.
- Writing up information: suiting discourse to needs and profile of audience/reader; managing and guiding listener/reader comprehension; anticipating and offsetting potential listener/reader difficulties; clarifying concepts; resolving doubts; etc.
- Text production: contextualising, planning, structuring, checking, revising, etc.
- Presenting ideas: contextualising the subject; properly focusing and framing it; summarising background; posing possible hypotheses; developing possible ramifications; formulating own hypothesis; drawing conclusions; etc.
- Argumentation: contrasting different points of view; delimiting own point of view; developing arguments on scientific bases; using persuasion strategies; aptly responding to listener/readers' demands; etc.
- Teamwork: asking and answering questions effectively; clarifying and negotiating objectives; agreeing ground rules of participation; promoting and facilitating participation; expressing own ideas briefly and concisely; obtaining relevant information and opinions; mediating in conflicts; negotiating and trying to reach agreements; etc.

Variable 9: Communicative language activities

- Oral comprehension activities: talks, explanations and discussions by colleagues, TV and radio programmes, etc.
- Reading comprehension activities: usual bibliography; handbooks and monographs, government, administrative and legal texts; etc.
- Oral expression activities: presenting scientific information and data; explaining ideas and opinions on subjects of interest; presenting research or innovation projects; communications on scientific subjects; public speaking; etc.
- Written expression activities: specialised articles; articles for the general public; research reports; lab reports; teaching materials; etc.
- Mediation activities: reviews and summaries; technical consultancy; adapting and simplifying scientific texts; didactic explanations; etc.
- Interaction activities: participation in debates and discussions; working in groups; directing workshops and seminars; didactic interaction with students; etc.

Variable 10: Text types

- Highly specialised texts: articles, discussions, news, etc.
- Technical content texts: catalogues, laboratory or research instrument user guides, instruction booklets, scientific appraisals, quality guides, etc.
- Academic texts: notes, monographs, lectures, laboratory training reports, etc.
- Talks/Writing for the public: educational materials, magazine articles, talks, leaflets, museum records, cataloguing and signage, etc.
- Legal writing: administrative and government regulations, legal reports, business laws, international recommendations, etc.
- Administrative/regulatory texts: agreements, contracts, investigations, *Agenda 21*-type protocols, etc.

Table 2b. General configuration of the domain-specific communicative framework for the Experimental Sciences: variables 6-10 (Ezeiza et al., 2007).

In view of the most general matters arising from the resulting analysis, the following conclusions should be stressed:

1) Students pursuing degrees in the Experimental Sciences should prepare to undertake work in a broad range of communication contexts, including academic, corporate, and educational venues and the news media.

2) They must also be prepared to undertake various discourse functions, including narrating, describing, defining, presenting information and data, explaining scientific matters, giving instructions, advising and recommending, issuing and justifying opinions, etc.

3) Even within highly restricted areas of knowledge, they must be able to cover a broad subject range, including theories, events, ideas, concepts, discoveries, experiments, projects, research, issues of public interest, etc.

4) Moreover, they must be able to adopt different approaches in addressing scientific topics: theoretical, applied or practical; pedagogical or generally informative; deliberative or critical; etc.

5) The diversity of academic and professional contexts requires that students be able to adapt to multiple modes of communication: public or private; domain-specific, interdisciplinary or transdisciplinary; speech or writing; live or recorded; synchronic or asynchronic; one-way or interactive; etc.

6) They also must be able to adapt to different types of (expert and non-expert) readers/listeners: academics, researchers, technical and administrative personnel, social influence groups, etc.

7) In addition, they must be able to communicate well through a variety of media: science journals, research reports, posters, information panels, teaching materials, administrative protocols, magazine articles, TV and radio programmes, documentaries, electronic media, etc.

8) They must master operations involved in documentation processes, including processing, interpreting and exploiting scientific material; text production procedures; strategies for effectively organising and presenting information; argumentation strategies; interpersonal communication strategies; etc.

9) They must be able to engage in very diverse activities of language comprehension, oral and written expression, inter- and intralinguistic mediation, and interaction.

10) They must familiarise themselves with a wide array of genres, including articles, papers, talks, communications and panel discussions; catalogues, booklets, reports and technical evaluations; science news, stories, monographs and general readership materials; administrative procedures and bureaucratic protocols; contracts, agreements, investigations, applications and projects; etc.

Generally speaking, therefore, these are the main variables to bear in mind when devising university programmes in domain-specific language.

Communicative profile of Experimental Sciences graduates

As can be seen, the prospects for didactic action being fostered by the ESHE are much broader and more complex than those contained in previous undergraduate programmes in the Experimental Sciences. In any case, however, the long experience gained in linguistic studies in this field and in the training and advising of science professionals in language matters, shows the concern felt in the scientific community over issues related to language and communication.

This concern is also reflected in the White Papers regarding new university degrees. A good example is the abundance of communication descriptors that I have been able to document in the White Paper sections outlining the objectives of the new undergraduate degrees and the professional profiles associated. These descriptors refer to very diverse types of capacities: capacities of an existential, social, or instrumental type or of a pragmatic-functional type; capacities concerned with proficiency in handling domain-specific discourse genres; capacities concerned with the mastery of professional communicative style; capacities concerned with the knowledge and use of specialised vocabulary; etc. A full list is provided in Tables 3a and 3b.

Component 1: Personal and social skills for domain-specific communication

- Broad background in classic and modern science
- Familiarity with the fundamental elements of communication and public perception of scientific innovations and their associated risks
- Knowledge of the importance of communication in conveying and perceiving scientific information.
- Capacity to place information and its interpretation in context in order to effectively convey compiled or acquired knowledge
- Critical and self-critical capacity applied to logical argumentation on questions of science, technology and mathematics
- Capacity to show the fun side of scientific knowledge
- Attitudes of awareness and understanding of others and their contributions, points of view and opinions
- Capacity to work and communicate in interdisciplinary groups
- Interpersonal skills associated with the ability to relate to others and work in groups
- Recognising the points of view and opinions of other members of the work group in order to easily handle interactions on the matters at hand in different communication contexts

Component 2: Instrumental skills for domain-specific communication

- Knowledge of information management systems and bibliographic databases
- Utilising Internet critically as a communication tool and source of information
- Advanced skills in handling bibliographic sources
- Capacity to look up and analyse relevant information for a given argument or science project
- Capacity to critically evaluate bibliography consulted and to put it into theoretical perspective
- Capacity to evaluate, interpret and summarise scientific data and information
- Skill in classifying or organising a complex corpus of information
- Capacity to structure information using comparative diagrams, concept maps, diagrams, etc.
- Proficiency in handling information-presentation instruments including Power Point type programs, audiovisual presentations, etc.

Component 3: Functional skills for domain-specific communication

- Knowledge of the conventions used in academic publications
- Knowledge of the rudiments of diverse languages (drawings, tables, formulas, graphs, etc.) used in academic genres
- Mastery of the basic strategies of analysis and synthesis applied to organising and integrating diverse information
- Precision in formulating arguments and ideas
- Capacity to interact easily on scientific subjects in different communicative situations
- Good oral and written communication skills demonstrated by easily and confidently presenting the results of an application or research project for critical evaluation by peers or reviewers in formal and informal environments
- Knowledge, abilities and skills for capturing the attention of clients, companies, government, etc.
- Capacity to communicate with non-experts when working as a guide or monitor, writer, reporter, specialised journalist, science writer or advisor
- Capacity to generate curiosity and interest in scientific subjects

Table 3a. Key capacities for effective mastery of domain-specific communicative competences in the Experimental Sciences: components 1-3 (Ezeiza et al., 2007).

From this broad spectrum of capacities, we see that a great deal is expected of Experimental Sciences graduates as far as domain-specific communicative skills are concerned. One of the most outstanding features of this profile is multi-faceted nature, since the scientist-communicator is now characterised from numerous angles and perspectives.

The opening premise is that science graduates are expected to show awareness and responsiveness to issues associated with the impact on society and social perception of scientific progress. Such awareness and responsiveness are reflected, for example, in students' capacity to empathise

with persons or groups manifesting concern or disagreement over scientific matters, and in their ability to develop clear, convincing arguments, to think critically and engage in self-criticism, and to effectively show different sides of scientific activity.

Component 4: Special discourse-writing knowledge
▪ Knowledge of the particular distinctive traits of scientific production
▪ Knowledge of the basic ways of logically and consistently organising scientific information
▪ Knowledge of proper academic modes of communication (descriptions, definitions, justifications, etc.)
▪ High level of comprehension of complex scientific talks and papers
▪ Capacity to process scientific, technical and mathematic information
▪ Skill at summarising scientific, technical, legal and administrative documents
▪ Capacity to relate and integrate information drawn from empirical observations and measurements, and theoretical assumptions in clear, logical and well-structured discourse
▪ Capacity to integrate into discourse written and oral textual, numeric, graphic, iconic, etc. information
▪ Capacity to build a solid defence of personal points of view based on well-grounded scientific knowledge
Component 5: Knowledge of the criteria behind academic and professional style
▪ Criteria and resources for clear, rigorous expression
▪ Mastery of text revision and editing techniques
Component 6: Specific lexical-semantic knowledge
▪ Knowledge of the main features of specialised terminology
▪ Knowledge of the main features of scientific nomenclature and international terminological conventions, and their adaptations to specific languages
▪ Knowledge of the particular vocabulary used in expressing the concepts inherent in each discipline in order to properly understand and convey scientific concepts, principles and theories
▪ Ability to utilise and criticise specialised terminology
▪ Skill at expressing self correctly using the principles, terms and concepts associated with the scientific discipline in question
▪ Ability to properly define the fundamental concepts of the scientific discipline in question so as to easily interact with others on the subject in different communicative situations

Table 3b. Key capacities for effective mastery of domain-specific communicative competences in the Experimental Sciences: components 4-6 (Ezeiza et al., 2007).

Similarly, science graduates are expected to know how to adapt themselves to the requirements of experts and non-experts with whom they must work in carrying out their professional tasks. In short, they are expected to be able to place scientific information and interpretation in context in order to respond adequately to the concerns and needs of widely different groups of people. Accordingly, they must be proficient in various forms of communication. They must be able to selectively handle a broad range of documentary resources and use them in intelligent ways. They must be familiar with different ways of organising information (diagrams, concept maps, tables, graphs etc.) and know how to use them effectively. And they must be skilled at handling audio-visual media, computer applications, internet and other electronic resources commonly used in scientific communication.

However, their capacities must not be confined to adequate contextualisation and effective communication of scientific information. In line with the above, Experimental Science graduates must be able to adapt their language to different levels of expertise. They must also be able to arouse curiosity and interest in science, and even be able to show how enjoyable and socially important it can be. This means that graduates in the Experimental Sciences must be able to choose from a broad, versatile repertoire of language. They must be familiar with the discourse properties (structure, organisation, functionality, etc.) of scientific communication, and they must also have the resources they need to express themselves clearly and concisely. They must know and apply general stylistic criteria and norms. And they must be able to demonstrate skill at using the fundamental elements of scientific terminology and domain-specific vocabulary in the different contexts of their future career.

Conclusions

Throughout this article, I have tried to provide at different levels an analysis of the communicative needs of Experimental Sciences graduates, taking as a reference the guidelines contained in the educational documents published to assist in the design of new undergraduate syllabi for the ESHE. To this end, I have revised some of the key epistemological sources of the new framework for university studies, and, using these sources as a basis, have made a close study of the White Papers published for 13 undergraduate degrees in the Experimental Sciences.

On the basis of this analysis, I have outlined the tasks that students are confronted with in this field of study as well as the communicative requirements that such tasks entail. Next, I have described the main features of the modes of communication associated with those tasks. Finally, I have noted the capacities that students must develop in order to respond successfully to the communicative demands of their field.

As we have seen, the declaration of intent of the ESHE appears relatively demanding, if we compare it with the previous situation in which communicative language competences were seen as a mere adjunct to academic and professional training in the sciences. Under the new framework, these competences have moved into the forefront and justifiably so, given the importance of science in all facets of professional activity and

society. On these new bases, scientific activity is seen as more closely linked to language than ever before. Indeed, science has surrounded itself with a space of communication that is particularly idiosyncratic and which is clearly and generally accepted as perfectly natural.

And thus arises the challenge. Today, adequate structural, programmatic and didactic solutions are required to address the situation. In other words, we must inevitably pose the question of how to structure education in such a way as to guarantee that these objectives will be met, or at least, to guarantee that Experimental Sciences graduates will have sufficient language skills to respond successfully to the demands of their academic and professional activity. Science requires that this be so, as does the world of business. And the social projection of science demands it most of all. As was aptly noted by Gutiérrez Rodilla (1998) in the title to his book, "science begins with speech".[7] If we share this conviction, we must not miss the opportunity afforded by the present period of renovation and change, but should address the challenge head on. I trust that this work will prove useful in this endeavour.

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NOTES

[1] I refer to the White Papers published by ANECA, the Spanish Quality and Accreditation Evaluation Agency. URL: http://www.aneca.es [30/10/2007]

[2] This article reports some of the results obtained from two R&D+I projects funded by the University of the Basque Country – PREST (GFAO6/06) and GARATERM (EJIEO7/O7), in cooperation with

the Provincial Council of Guipúzcoa and the Basque Government, respectively. Both projects are available at http://www.euskaraztrebatzen.org.

[3] This study takes into account the White Papers for the following experimental sciences degrees: biochemistry, biotechnology, oceanography, statistics, biology, nutrition, dietetics, environmental science, physics, optics, chemistry, mathematics and geology (URL: http://www.aneca.es/publicaciones/libros-blancos.aspx).

[4] For further discussion, see Ezeiza et al. (2007) and Ezeiza (2008).

[5] These White Papers are available at URL: http//www.aneca.es/publicaciones/libros-blancos.aspx

[6] My position regarding experiential learning owes much to authors such as Kolb (1984), Kohonen (1992, 2000 & 2001) and Korthagen (2001).

[7] The title of one of this author's best-known works.