Spanish for the sciences: A communication-based approach

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Abstract

This paper describes the design and implementation of an advanced Spanish for the sciences course at the college level in the United States. The course is centered on public dissemination and scholarly communication, as opposed to the predominant approach of focusing on scientific content areas. The main idea was to follow a Languages Across the Curriculum (LAC) model that shifts the responsibility of providing the scientific content of the course from the instructor to the students, allowing them to: 1) develop technical and scientific communication skills and materials, 2) explore the interrelated notions of science and culture in Spanish-speaking societies, 3) draw connections between their knowledge of both Spanish language and the sciences, 4) compare what "science" means to them to the ways this concept is perceived around the Spanish-speaking world, and 5) participate in Spanish-speaking scientific communities.

Keywords: Languages Across the Curriculum, Spanish for Specific Purposes, Spanish for Science and Technology, Spanish for the Professions, curriculum design.

Resumen

Español para las ciencias: un enfoque basado en la comunicación

Este artículo describe el diseño y la implementación de un curso avanzado de español para las ciencias a nivel universitario en los Estados Unidos. El curso se centra en la divulgación y la difusión científicas, en contraposición con el enfoque predominante de concentrarse en áreas de contenido científico. La idea principal fue seguir un modelo de lenguas a través del currículo (LAC por sus siglas en inglés) que traslada la responsabilidad de proveer el contenido científico del curso del instructor a los estudiantes, permitiéndoles a estos últimos: 1)

desarrollar habilidades y materiales de comunicación técnica y científica, 2) explorar las nociones interrelacionadas de ciencia y cultura en sociedades de habla hispana, 3) establecer conexiones entre su conocimiento de la lengua española y las ciencias, 4) comparar lo que el término "ciencia" significa para ellos con las formas en que este concepto es percibido en el mundo hispano y 5) participar en comunidades científicas hispanoparlantes.

Palabras clave: lenguas a través del currículo, español para fines específicos, español para ciencia y tecnología, español para las profesiones, diseño curricular.

1. Introduction

In its 2017 report on the state of language education in the United States, the American Academy of Arts & Sciences recognized that "the nation's competitiveness in scientific and technological innovation would be improved if researchers were able to communicate and translate their findings internationally and to account for the work of scientists who reported their findings in non-English journals" (Commission, 2017: 2). This acknowledgement echoes past calls from several other organizations and agencies in the country, including a 2013 position statement of the American Council on the Teaching of Foreign Languages (ACTFL) on the role of languages as a core component of education, as they provide "access to information and collaboration in any field – including science, technology, engineering, mathematics" (ACTFL, 2013).

When it comes to the Spanish language, curricular offerings related to scientific and technological disciplines have been part of the growing number of Spanish for Specific Purposes (SSP) and Spanish for the Professions (SP) courses in the United States. Two decades ago, in the preface to the farseeing volume *Spanish and Portuguese for Business and the Professions*, Alvord G. Branan projected the proliferation of SSP and SP programs across the country, stating that "the [foreign language for business] movement will spread, as it has already begun to do, to all the professions: medical and health care, social work, law, science, and technology" (Branan, 1998: 5). Although mostly accurate in his predictions, Branan's uplifting perspective has failed to materialize when it comes to a significant increase of Spanish language courses related to science, technology, engineering, and mathematics (STEM), where the pace of growth so far does not measure up to that in other areas, particularly, when compared to the numerous options

now available of Spanish for the health professions (e.g., Hardin, 2015). In the chapter of the aforementioned volume dedicated to science and technology, María Cooks recognized that the "main problem in designing courses for science and technology involves the area of concentration" (Cooks, 1998: 407), proposing the development of language courses around "cluster issues" such as the environment or biotechnology, and not traditional disciplines like physics or biology. Although this approach addresses some of the challenges that have limited the expansion of Spanish for STEM (S-STEM) offerings, it still presents some practical implementation limitations, especially at smaller institutions, since it requires recurrent partnerships between language and science instructors (or language instructors trained in scientific content) and a critical number of students interested in the particular cluster issue that are also willing to enroll in the course.

The present article describes the development of an advanced Spanish for the Sciences course within the framework of Languages Across the Curriculum (LAC) and based on standards by the American Council on the Teaching of Foreign Languages. The course was implemented at Skidmore College, a private liberal arts college in upstate New York, during the fall semester (September to December) of 2016. This course is particularly innovative because it is centered on scientific communication (public dissemination and scholarly communication), as opposed to placing an emphasis on scientific content areas, which has been the norm for this type of courses. On the one hand, the focus on communication of such a course responds to best practices and standards of language learning. On the other hand, this model provides a viable framework to facilitate the proliferation of Spanish for science and technology offerings within language departments and programs at institutions of higher education, given that the course can be adapted to particular needs and availability of resources, as has been the case in other areas of the Spanish for Specific Purposes (SSP) spectrum (e.g., Sánchez-López, 2010).

2. Spanish for STEM in U.S. Higher Education

Although courses specifically designated as some variation of "Spanish for Science" or "Spanish for Engineering" have been present in the United States for a long time (e.g., Willcox, 1913; Williams, 1925, 1929), they are

currently not easy to come by in course catalogs of institutions of higher education, with the notable exceptions of Georgia Tech (SPAN 3693 Science and Technology, SPAN 4061 Science & Technology I, SPAN 4062 Science & Technology II), Scripps College (SPAN 070 SC Advanced Spanish: Spanish for Science), Texas A&M University (SPAN 307 Spanish for the Sciences), University of Alabama (SP 104 Spanish for Engineering), University of Pittsburgh at Johnstown (SPAN 0106 Spanish for Science and Engineering), University of Virginia (SPAN 2015 Spanish for Engineering), and the International Engineering Program at the University of Rhode Island, where students not only take technical Spanish courses on campus, but can spend a year taking STEM-related courses abroad. The limited offerings contrast with the significant growth of SSP courses in business and education, and to a lesser degree, law and social work (Long & Uscinski, 2012). the existence of such courses does, however, highlight the growing diversification of SSP offerings and the need they intend to fulfill within the higher-education Spanish language curriculum, more so if we consider that the second largest group of SSP courses up until 2011 comprised those focusing on an area where Spanish language and the sciences converge: Spanish for medicine and the health professions (Long & Uscinski, 2012).

As language educators explore different pedagogical models that could support S-STEM offerings, some approaches seem markedly appropriate due to the possibilities they offer to integrate language learning in the context of scientific and technological disciplines, including project-based (e.g., García González & Veiga Díaz, 2015) and service-based (e.g., Sánchez-López, 2013; Ruggiero, 2015) learning. In particular, the Languages Across the Curriculum (LAC) approach has been suggested as an effective methodology to develop language courses focusing on STEM. In fact, other scholars have reported successful implementations, including the development of German courses for engineering (Kirchner, 2000).

3. Languages Across the Curriculum (LAC) Models

In the introduction to *Languages Across the Curriculum: Interdisciplinary Structures and Internationalized Education*, an essential volume for those interested in the topic, Maria-Regina Kecht and Katharina von Hammerstein (2000) described some of the defining characteristics of LAC models, mainly that they are a curricular response to "students' insufficient language competence and the

disjointed nature of their education," in which "[s]tudents are engaged in active and relevant uses of their language skills as they apply them to subject areas of their choice" through a "content-driven, task-oriented, and learner-centered approach that prepares students for real-life use of a language" (Kecht & von Hammerstein, 2000: xxi). This broad framework has allowed the implementation of very different models at various institutions throughout the years, each one with very particular characteristics. Currently, Languages Across the Curriculum (LAC) and Cultures and Languages Across the Curriculum (CLAC) work more like an umbrella framework that encompasses a diverse array of offerings, from "content courses taught entirely or partially in languages other than English" to "linked language and content courses" (CLAC Consortium, *What is CLAC?*: n.d.). That is, there is no one single LAC/CLAC model, but an array of several models that respond to the specific needs of students, colleges, and programs (CLAC Consortium, *CLAC Models*: n.d.). There are, however, a set of principles that guide these programs, particularly, the "meaningful use of language," or in other words, "the use of language within an authentic cultural context" to "approach subjects and experiences outside the traditional language classroom" (CLAC Consortium, *Principles of CLAC*: n.d.).

Given the numerous possibilities, when talking about LAC/CLAC, it becomes necessary to describe the characteristics of each specific program. At Skidmore College, LAC was first implemented in 2000 under a Title VI grant, evolving from a trial period of non-credit offerings in the first years, to 1-credit (intermediate) and 2-credit (advanced) courses established by 2006. And unlike many other programs across the United States, LAC courses at Skidmore College are taught by faculty in the Department of World Languages and Literatures as standalone sections not linked to any other particular content course, regularly being offered in six languages (Chinese, French, German, Italian, Japanese, and Spanish). The goal is to let students naturally connect LAC courses to other courses or areas of the curriculum without enforcing specific links. For example, a student writing a thesis, and enrolled in an intermediate LAC course, could read materials in Spanish directly related to the topic of their thesis and write about such materials, while another student taking a biology class, and enrolled in the same intermediate LAC section, could read and report about biology-related texts.

When it comes to Spanish language, there have been numerous reports of LAC offerings related to other disciplines, such as history, social sciences,

and international relations (Klee & Barnes-Karol, 2006), with different degrees of success. Regarding STEM, Barbara Domcekova (2010) has described the implementation of one-hour-per-week Spanish "enhancement sections" in Environmental Studies and Chemistry, made possible by the collaboration between language and science faculty, that is, a LAC model where a specific science course taught in English is linked to a Spanish language section. Addressing some of the challenges of implementing such offerings, Domcekova identifies "three main issues we still need to address on our campus: faculty compensation, increased visibility/publicity, and scheduling" (2010: 142). In general terms, these issues are related to resource allocation, enrollment, and logistics. For example, in terms of logistics, "[s]cheduling [of enhancement sections] requires additional cooperation between the science and language faculty and coordination of multiple schedules" as they "cannot be scheduled for days/hours conflicting with other science and language courses" (2010: 142). Furthermore, as described by the author, faculty have not been compensated for their participation in this initiative, but it is hoped "that growing enrollments in the program will spur the administration to consider additional faculty compensation," since enrollments "have been small but steadily increasing" (2010: 142), and hence the need for more visibility/publicity. In the present article, it is suggested that one way to address such issues, especially at small institutions where they can be magnified, is to offer standalone Spanish LAC sections (or SSP courses inspired by LAC principles) focused on different areas of communication within STEM (science journalism, science documentary film, scholarly communication, policy-oriented presentations, etc.), that widen the target audience, offer more flexibility in terms of the scientific and technical content, and avoid some of the logistical concerns mentioned above.

4. Scope of a Spanish for the Sciences Course

A course of Spanish for the Sciences at Skidmore College was originally conceived to fulfill the needs of advanced Spanish learners interested in improving their language skills within the context of STEM, particularly the natural sciences, whether majoring in a science-related discipline or not. Additionally, the course was meant to attract students that traditionally would not enroll in advanced language courses focused on literature and cultural studies offered by the Department of World Languages and

Literatures. As with other LAC courses at Skidmore College, the course was a standalone offering where students were encouraged to explore their interests and current or past research work in any scientific discipline through the Spanish language. The course was offered for the first time during the fall of 2016. There were 10 students enrolled, with the following distribution by declared major: one was a Spanish major, one was a double-major in Spanish and a scientific discipline, four were majoring in a science-related discipline only, and four were majoring in a discipline other than Spanish or the natural sciences. Although this is a small sample, this distribution shines light on the type of students that such a course could attract. In this case, eight out of the ten students in the class would typically not enroll in an advanced Spanish course.

From the very beginning, the course was envisioned to be communicative in nature with a visual literacy component, as financial support was received from Project Vis, a three-year initiative sponsored by the Andrew W. Mellon Foundation to increase visual literacy on campus. However, a more complex question soon emerged. If students were to be prepared for "real-life use of language," what is, and will continue to be, the real-life use of Spanish in the natural sciences in particular and in STEM more generally? This is not an easy question to answer, especially at a time when it has been stated that "English is not only the dominant form of international scientific publication and oral communication at conferences and in multinational laboratories—it is almost always the *only* language of such communication" (Gordin, 2015: 293). To this respect, a series of position essays included in the volume *El español, lengua de comunicación científica* (García Delgado et al., 2013) can be enlightening.

The future of the Spanish language in scholarly communication—what in Spanish is known as *difusión*—seems to be a contentious issue among scholars, with opinions divided between those who think that championing Spanish as a language of communication among scientists is a lost battle (e.g., Arango, 2013), and those who advocate for a vibrant language that encompasses all aspects of human knowledge, including scientific and technical scholarly communication (e.g., Vivanco Cervero, 2009; Campos 2013). Nevertheless, most scholars that contributed to the aforementioned volume seem to agree on the vital role that Spanish plays, and will continue to play, in the public dissemination of scientific and technological knowledge, or *divulgación* (e.g., García Cañete, 2013).

More recently, Pilar Barreiro Elorza and Carmen Sancho Guinda have described a Content and Language Integrated Learning (CLIL) teaching initiative for engineering students at Universidad Politécnica de Madrid that places emphasis on recognizing "communities of practice and their background and experience with the genres, modes, and the new discourses they engender" (2016: 39), that is, the authors recognize the importance of genre literacy in "real-life" language use in scientific and technological fields. This perspective should not seem unexpected, since there is an extensive body of literature on the notion of genre in Language for Specific Purposes, particularly in English (e.g., Paltridge, 2001; Swales, 2004; Tardy, 2009; Nesi & Gardner, 2012; Hyon, 2018).

Having these considerations in mind, it was decided that the main emphasis of the course was going to be on scientific communication. In addition, a significant portion of the course would be organized around genres of both scholarly communication and public dissemination of science.

5. Standards-Based Course Design

When designing the course, the *World-Readiness Standards for Learning Languages* (National Standards, 2015a), and particularly the Standards for Learning Spanish (National Standards, 2015b), were embraced as a roadmap. And following principles of backward design (Wiggins & McTighe, 2005), six learning goals were defined to inform the assessment strategies that will later be mapped into corresponding tasks, assignments, and projects, called learning scenarios in this article. Table 1 provides an overview of the alignment between World-readiness Standards goal areas and the course learning goals. Finally, the resulting learning scenarios were organized into three thematic modules.

Goal Area	Learning Goal
Communication	Learning Goal 1 (LG1): Students can read, summarize, and analyze technical texts in their scientific area of interest.
	Learning Goal 2 (LG2): Students can create and present basic science communication and public dissemination materials in Spanish.
Cultures	Learning Goal 3 (LG3): Students can describe scientific practices in the Spanish-speaking world by analyzing scientific communication materials
Connections	Learning Goal 4 (LG4): Students can draw connections between their knowledge of both Spanish language and the natural sciences
Comparisons	Learning Goal 5 (LG5): Students can compare what "science" means to them to the ways this concept is perceived around the Spanish-speaking world
Communities	Learning Goal 6 (LG6): Students can participate in Spanish-speaking professional communities in the sciences.

Table 1. Course learning goals by goal area.

The following sections include a description of the main learning scenarios that were developed. For a summary of the targeted course learning goals and standards by learning scenario see Table 2. Additionally, a sample calendar of the course organized by modules can be found in Appendix 1.

Learning Scenario	Targeted Learning Goals	Targeted Standards
Learning Scenario 1: Designing the Syllabus	LG1, LG3, LG4, LG5	Interpretive Communication, Presentational Communication, Practices of Culture, Products of Culture, Making Connections, Language Comparison, Cultural Comparisons.
Learning Scenario 2: Individual Reflections on Scientific Communication Materials	LG1, LG2, LG3, LG4, LG5	Interpretive Communication, Products of Culture, Making Connections, Acquiring Information, Language Comparison, Cultural Comparisons.
Learning Scenario 3: Meet the Scientists	LG3, LG5, LG6	Practices of Culture, Cultural Comparisons, School and Community, Lifelong Learning
Learning Scenario 4: Poster Session	LG1, LG2, LG3, LG4	Interpersonal Communication, Interpretive Communication, Presentational Communication, Products of Culture, Making Connections, Acquiring Information.

Table 2. Targeted course learning goals and standards by learning scenario.

5.1. Learning Scenario 1: Designing the Syllabus

Targeted Standards: Interpretive Communication, Presentational Communication, Practices of Culture, Products of Culture, Making Connections, Language Comparison, Cultural Comparisons.

Targeted Learning Goals: LG1, LG3, LG4, LG5.

It was expected that the students would use their language skills to explore content of their interest in the sciences, particularly the natural sciences. Consequently, the students were in charge of shaping the "scientific" part of the course. That is, they had to use their language skills to search and choose texts that everyone in the class would read or watch, in the case of films, and discuss. The students were encouraged to select texts closely related to their interests or field of specialization, if applicable. As it was initially outlined, the scientific content was expected to come from sources of public dissemination (*divulgación*) and scholarly communication (*difusión*) in Spanish. During the first week of classes, the students were assigned specific genres of scientific communication. Types of texts included science news articles, science documentaries, research articles, research posters, and examples of visual presentation of scientific data, among others. In order to find such texts, the students were provided with a list of newspapers, streaming websites, research databases, and institutional repositories in Spanish (see Appendix 3). The students had to deeply engage with the texts, so they were not only responsible for finding them and making them available to the class, but also presenting them and leading the discussion that day. For example, those who chose the science documentary film genre received a list of websites with documentary collections. Two weeks before their presentation, the instructor received from the students a link to the documentary film they had chosen in order to make it available to their classmates so everyone could watch it. The students selected an episode of the series *El hombre y la Tierra* [*Men and Earth*], that ran from 1974 to 1981, by the renowned Spanish science popularizer Félix Rodríguez de la Fuente. The film is available on RTVE.es, the website of the public radio and television company in Spain (Radio y Televisión Española). During the presentation of the film, centered on Iberian nocturnal raptors, students not only noted linguistic and visual elements, but also the particular scientific methods shown in the documentary to track the birds. Then, they raised the question "Who was the audience of this documentary?" The discussion that followed included the description of some of the characteristics of the Spanish society at the end of the 1970's.

5.2. Learning Scenario 2: Individual Reflections on Scientific Communication Materials

Targeted Standards: Interpretive Communication, Products of Culture, Making Connections, Acquiring Information, Language Comparison, Cultural Comparisons.

Targeted Learning Goals: LG1, LG2, LG3, LG4, LG5.

Starting on week three, and approximately every week or every other week, students had the opportunity to submit individual reflection papers related to the topic being discussed in class at the time. Out of a total of eight optional reflection papers, students were required to complete three. The number of papers required was a result of considerations that had to do with student workload expectations associated with a 2-credit course, the time required for other course assignments, and to provide an opportunity for students to concentrate on their individual interests and goals, a characteristic of Language Across the Curriculum courses at this particular institution. Each assignment had specific instructions and objectives, always keeping in mind a particular type of scientific communication text. For example, during the fourth, fifth, and sixth week of classes the discussion centered on science journalism. Students were directed to read reference texts on the characteristics of scientific news articles. Appendix 1 provides a list of the bibliographic materials provided and the reference texts assigned. These texts emphasized how to write a news article based on the results reported in a scholarly one.

As an individual reflection paper, students were asked to find and analyze an article of science journalism. A list of science sections in popular Spanish-speaking newspapers was provided. Then, they were required to reflect on things like the effectiveness of the title, the structure and organization of information, rhetorical strategies and figures of speech used (such as the use of similes, quotes, examples, etc.) in this particular genre, vocabulary (abundance or lack of technical terms), and target audience. Additionally, they were directed to comment on the scientific content, in order to promote connections with the scientific knowledge they already possessed.

In a following reflection paper, students had to write a news article based on a scholarly one. In class we went over sources for science news, with emphasis on articles in scientific journals. To complete this assignment, students had to perform a search in order to find a scholarly article written in Spanish in an area of their interest. A list of scholarly search engines, databases, and institutional repositories was provided (see Appendix 3). Also, a class was dedicated to familiarize all students with two leading open-access databases with a vast number of scholarly articles written in Spanish: Redalyc and SciELO. Although the course was branded as "Spanish for the Natural Sciences," after performing initial searches, students soon realized that the

notion of "science" in English, usually associated with the natural sciences, is much more fluid in the Spanish language. This aspect became evident when they navigated collections of *revistas científicas*, noting that when most Spanish-speaking scholars use the adjective *científico/a*, they are discussing a broader domain that can include, for example, the social sciences and even the humanities. Once a scholarly article was chosen, students faced the challenge of reporting the most important and relevant results to a non-expert audience. This exercise helped them reflect, by doing, on the rhetorical mechanisms and practices used by science journalists, and then make comparisons to those used by scientists to communicate with other peers within their community of professionals.

The individual reflection papers were designed to promote a deeper student engagement with various scientific communication texts, giving students the possibility to choose the genres that interested them the most. Additionally, these assignments helped students face their own preconceived notions about certain topics, providing direction on how to identify such preconceptions in order to foster a more nuanced and critical reading.

5.3. Learning Scenario 3: Meet the Scientists

Targeted Standards: Practices of Culture, Cultural Comparisons, School and Community, Lifelong Learning.

Targeted Learning Goals: LG3, LG5, LG6.

An important goal of the class was to foster student participation in scientific communities using the Spanish language. One way to accomplish such goal included transforming the classroom into a space where students could interact with science professionals who use or had used Spanish in professional environments, so they could establish relationships that were likely to grow beyond the classroom. A natural group of professionals to consider was Spanish-speaking scientists at our institution and other institutions in the area, anticipating that the physical proximity would make constant contact possible, if desired.

The instructor coordinated the visits to class, on different days, of three local Spanish-speaking scientists. These included two faculty members from Skidmore College's Departments of Physics and Chemistry, and one faculty member from a nearby research university who specializes in molecular biology. Before the day of the visit, the instructor provided the students with

biographic information along with a sample of the visiting scientist's work (when available, the visitor's website that contained a list of bibliographic information and descriptions of their interests and projects), and asked students to prepare at least two questions for the visitor. Scientists visited the class on different days, and spent about 20 minutes talking in Spanish about their careers and their work. The presentation was followed by a 20- to 30-minute session when students asked the questions they had prepared in advance. The type of questions showed interest in the scientist's career and research projects as well as their experiences using the Spanish language and their personal journeys. In the case of institutions where such visits are not possible, similar sessions can be scheduled by contacting scientists at other universities, for example, those located in Spanish-speaking countries, and arrange "virtual visits" via video chat services such as Skype, Google Hangouts, or Facebook Messenger's video chat.

5.4. Learning Scenario 4: Poster Session

Targeted Standards: Interpersonal Communication, Interpretive Communication, Presentational Communication, Products of Culture, Making Connections, Acquiring Information.

Targeted Learning Goals: LG1, LG2, LG3, LG4.

In the second half of the semester, and once students became familiar with different genres of scientific communication, they had to collaborate with a partner to create a research poster. The poster was the result of at least two months of research, when they went through many of the steps followed by experienced scholars. As part of the process, students had to agree on a topic of interest, conduct a literary review (using the skills developed in the first half of the semester), propose a preliminary draft, and submit it to peer-review (performed by their classmates during a session devoted to this end). In addition, the instructor provided feedback at different stages of the process. Students had complete freedom with respect to the kind of research they wanted to pursue, from reports of projects they were working on in other classes or in which they had participated, to a critical comparison of the findings of at least three different scholarly articles related to a specific topic. On the last day of classes, students had to present their posters in a *Jornada científica y tecnológica* (Science and Technology Open Day) that anyone on campus was welcome to attend (getting extra encouragement by some light refreshments), and much like the way research posters are presented

during a major conference. Having to present the results of their work to an audience other than their instructor not only gave students the opportunity to practice their Spanish language skills in a real-life setting, but also to face many of the challenges that come with doing research, including self-reflection on its relevance to the general public.

6. Implementation

The course was branded as "Advanced LAC: Spanish for the Natural Sciences," to emphasize its connection to the Languages Across the Curriculum approach and to attract students from the natural sciences that would normally not consider taking an advanced Spanish course. The title was also a subtle way to reference the differences between the term *science* (frequently used to indicate the natural sciences) and the broader term *ciencia*, differences that would be addressed in the class. As mentioned before, the course was organized around three thematic modules: a brief introductory module where students reviewed some basic communication tools (general topics included the metric system, "reading math," and linguistic mechanisms to form technical terms), a longer module on scientific communication, and a final module on the state of science and technology in the Spanish-speaking world. The sample calendar included in Appendix 1 offers an overview of the materials covered in each module. Appendix 2 provides a summary of student assessment components.

At the end of the semester, students were asked to identify strengths and areas of improvement of the course in an anonymous online survey. The survey consisted of the following three open-ended questions: "1. Please identify what you consider to be the strengths of the course," "2. Please identify areas where you think the course could be improved," and "3. Any additional comments?" In terms of strengths, some of the responses were related to the learning scenarios ("I thought the projects throughout the course – such as the presentation and poster – were good to apply the techniques and practices taught in the course"), the connections they were able to make ("I liked how applicable the course was to my other major and how many different topics it covered"), the comparisons and cultures goal areas ("The assignments were all very effective in forcing me to analyze in depth the efficiency of science reporting and the involvement of the Spanish speaking world in science"), and the modes of communication ("The

prevalence of open group discussions provided me with confidence to speak about scientific topics in Spanish"; "I also found the class discussions were good to discuss the readings in depth").

In terms of areas of improvement, the most common themes had to do with the selection of readings ("I found some of the readings to be very tedious and redundant"; "Some of the readings were very long/technical/hard to get through") as well as the relationship between the topics covered and the amount of time available ("There was also a lot of information to get through in a short period of time. Either changing the course to 4 credits or meeting once for three hours at a time each week might help"; "I think it could be more effective as a three credit course rather than a two credit course"), challenges that can be addressed by adjusting the sample calendar provided in Appendix 1.

7. Final Remarks

The course described in this article provides a roadmap for the design and implementation of courses at the intersection of language learning and the sciences. To this respect, two innovative aspects have been proposed. First, an emphasis on scientific communication that allows instructors in language departments to focus on what they know best: the use of language and the improvement of communication skills. Second, a Languages Across the Curriculum approach that encourages students to make connections between the target language and their own individual scientific interests. Furthermore, by putting the responsibility of the scientific content on students, such a course need not be linked to a particular scientific discipline and can welcome students with a wide variety of backgrounds. This approach allows instructors the possibility of not only adjusting the course to meet students' needs, but also, for those who are not too familiar with specialized scientific content, to meaningfully facilitate learning in the classroom. These two aspects can foster the growth of Spanish for STEM course offerings at institutions of higher education, particularly those offered by language departments, as they address some of the common challenges that these type of courses have faced in the past.

However, this particular framework might not offer the best solution for all cases. For example, it may not be the best fit for those interested in areas of STEM communication that are less dependent on written materials, such as

interpreting or workplace interpersonal communication, where other methodologies such as content-based, project-based, or service-based learning can prove more effective. Nevertheless, it is the author's hope that the present work will encourage others to rethink this crucial area of the Language for Specific Purposes (LSP) curriculum, so it continues to grow.

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Appendix 1

Sample Calendar for a Spanish for the Sciences Course

The following sample calendar has been slightly adjusted, for clarity and logistical improvements, from the one followed when the course was first taught. The original syllabus is available upon request.

Codes used:

LS1-Learning Scenario 1. Designing the Syllabus.

LS2-Learning Scenario 2. Individual Reflections on Scientific Communication Materials (students are required to write a total of three reflection papers out of eight options).

LS3-Learning Scenario 3. Meet the Scientists.

LS4-Learning Scenario 4. Poster Session

Module 1 **Basic Scientific Communication Tools**			
Date	**Topic**	**Read/study before class**	**Assignments due**
Week 1, Day 1	Introduction to the course, scope, and approach.		
Week 1, Day 2	The metric system and the language of math	Handout on how to read numerical expressions in Spanish.	
Week 2, Day 1	The creation of technical terminology in Spanish: Neologisms of form	Gutiérrez Rodilla, B. (2005). La creación terminológica: Neología de forma. In *El lenguaje de las ciencias* (pp. 43-55). Madrid, Spain: Gredos.	
Week 2, Day 2	The creation of technical terminology in Spanish: Neologisms of meaning	Gutiérrez Rodilla, B. (2005). La creación terminológica: Neología de sentido, neología sintáctica, neología de préstamo. In *El lenguaje de las ciencias* (pp. 57-65). Madrid, Spain: Gredos.	
Week 3, Day 1	The language of statistics	Handout on how to read statistical expressions in Spanish.	LS2-Option 1 Individual reflection paper: Choose a science news article, identify 10 technical terms, and suggest the possible mechanisms for their creation. Explain your reasons.

Module 2 **Scientific Communication**			
Date	**Topic**	**Read/study before class**	**Assignments due**
Week 3, Day 2	Introduction to scientific communication	Read pp. 174-182. Fernández Bayo, I., & Angulo, E. (2011). El lenguaje y los formatos en la comunicación de la ciencia. In C. Moreno Castro (Ed.), *Periodismo y divulgación científica: tendencias en el ámbito iberoamericano* (166-189). Madrid, Spain: Biblioteca Nueva.	
Week 4, Day 1	Public dissemination of science: Science news article	Read pp. 146-156. (5.4 El periodista científico como traductor de lenguajes; 5.5 Cómo elaborar un	

		texto periodístico a partir de uno científico) Elías, C. (2008). *Fundamentos de periodismo científico y divulgación mediática*. Madrid, Spain: Alianza.	
Week 4, Day 2	Public dissemination of science: Science news article	LS1 Article proposed by students: Science news.	LS1 Presentation by students: Science news article. LS2-Option 2 Individual reflection paper: Choose and analyze a science news article.
Week 5, Day 1	Public dissemination of science: Sources	Handout on sources of scientific news: Scholarly databases, academic search engines, and institutional repositories in Spanish.	
Week 5, Day 2	Public dissemination of science: Science documentary	Read pp. 131-140. León, B. (2010). La ciencia en imágenes. Construcción visual y documental científico. *ArtefaCToS*, *3*(1), 131-149.	LS2-Option 3 Individual reflection paper: Write a science news article.

Module 2 **Scientific Communication**			
Date	**Topic**	**Read/study before class**	**Assignments due**
Week 6, Day 1	Public dissemination of science: Science documentary	Read pp. 140-149. León, B. (2010). La ciencia en imágenes. Construcción visual y documental científico.	
Week 6, Day 2	Public dissemination of science: Science documentary	LS1 Film proposed by students: Science documentary.	LS1 Presentation by students: Science documentary.
Week 7, Day 1	Professional communication in science: Technical writing	Read pp. 157-160 (Recursos gramaticales y estilísticos) García-Cervigón, A. (2007). El discurso científico y tecnológico y la lengua española. In R. Sarmiento, F. Vilvhes (Eds.), *Neologismos y sociedad del conocimiento* (pp. 153-167). Barcelona, Spain: Ariel.	LS2-Option 4 Individual reflection paper: Choose and analyze a science documentary.
Week 7, Day 2	Technical writing	LS1 Technical text proposed by students: Emphasis on use of language.	LS1 Presentation by students: technical writing.
Week 8, Day 1	Professional communication in science: The IMRaD format	Read pp. 4-14 (Cap. 2 Los orígenes de la redacción científica; Cap. 3 ¿Qué es un artículo científico?) Day, R. A. (2005). *Cómo escribir y publicar trabajos científicos*. Washington, D.C: Organización Panamericana de la Salud.	
Week 8, Day 2	The IMRaD format	LS1 Scholarly article proposed by students: Emphasis on organization and structure.	LS1 Presentation by students: Organization and structure of scientific texts (IMRaD format)

Module 2 Scientific Communication			
Date	**Topic**	**Read/study before class**	**Assignments due**
Week 9, Day 1	Scientific texts: Visual presentation of data	Feria, M. (2010). Consejos para la confección de gráficos científicos. In E. Serés, L. Rosich, & F. Bosch (Eds.), *Presentaciones orales en biomedicina. Aspectos a tener en cuenta para mejorar la comunicación* (pp. 45-56). Barcelona, Spain: Fundación Dr. Antonio Esteve.	LS2-Option 5 Individual reflection paper: Choose a scholarly article and critically comment on at least three of the following aspects: title, organization, use of language, content, target audience.
Week 9, Day 2	Scientific texts: Visual presentation of data	LS1 Scholarly article proposed by students: Emphasis on visual presentation of data.	LS1 Presentation by students: Visual presentation of data.
Week 10, Day 1	Scholarly communication: The content of a research poster	Read pp. 85-91. Guardiola, E. (2010). El póster científico. In E. Serés, L. Rosich, & F. Bosch (Eds.), *Presentaciones orales en biomedicina. Aspectos a tener en cuenta para mejorar la comunicación* (pp. 85-102). Barcelona, Spain: Fundación Dr. Antonio Esteve.	LS2-Option 6 Individual reflection paper: Choose a scholarly article and analyze the visual presentation of data.
Week 10, Day 2	Scholarly communication: The format of a research poster	Read pp. 91-102. Guardiola, E. (2010). El póster científico.	
Week 11, Day 1	Scholarly communication: Discussion of a research poster	LS1 Research poster proposed by students.	LS1 Presentation by students: Research poster. LS2-Option 7 Individual reflection paper: Choose and analyze a research poster.

Module 3 Science and Technology in the Spanish-Speaking World			
Date	**Topic**	**Read/study before class**	**Assignment due**
Week 11, Day 2	State of science and technology in the Spanish-speaking world	RICYT (2015). El estado de la ciencia en imágenes. In *El estado de la ciencia: Principales indicadores de ciencia y tecnología iberoamericanos/ interamericanos* (pp. 13-28). Buenos Aires, Argentina: Author.	LS4 First draft of research poster to be submitted to instructor. LS2-Option 8 Individual reflection paper: El estado de la ciencia en imágenes.
Week 12, Day 1	Scientific communities: Guest scientist visit	LS3 Read information provided about guest.	LS3 Prepare at least two questions for guest.
Week 12, Day 2	Scientific communities: Guest scientist visit	LS3 Read information provided about guest.	LS3 Prepare at least two questions for guest.

Week 13, Day 1	Peer review of research poster		LS4 All students need to bring to class a printed copy of the second draft of their research poster for peer review.
Week 13, Day 2	Scientific communities: Guest scientist visit.	LS3 Read information provided about guest.	LS3 Prepare at least two questions for guest.
Week 14, Day 1	Future of the Spanish language in the Sciences	Choose one essay, out of the fifteen available, and prepare to defend the position of the author during an in-class debate: García Delgado, J. L., Alonso, J. A., & Jiménez, J. C. (Eds.). (2013). Quince acotaciones. In *El español, lengua de comunicación científica* (pp. 421-482). Barcelona, Spain: Ariel.	
Week 14, Day 2	*Jornada científica y tecnológica*: Science and Technology Open Day		LS4 Presentation by all students: Research poster.

Appendix 2

Student Assessment

Student assessment consisted on the following components. Evaluation rubrics are available upon request.

Preparation/Participation (20%)

Attendance (5%)

Individual Reflection Papers, LS2 (30%)

Selection of Text and Presentation, LS1 (20%)

Research Poster, LS4 (25%).

Appendix 3

Resources

Databases and Search Engines of Scientific Journals from Latin America and Spain
Dialnet, http://dialnet.unirioja.es
Latindex, http://www.latindex.unam.mx
Redalyc, Red de Revistas Científicas de América Latina, el Caribe, España y Portugal http://www.redalyc.org
SciELO, Scientific Electronic Library Online, http://www.scielo.org

Institutional Repositories
LA Referencia, http://www.lareferencia.info/joomla/
Repositorios Institucionales Españoles de Acceso Abierto, http://www.accesoabierto.net/repositorios/

Public Dissemination of Science in Spanish

Agencia iberoamericana para la difusión de la ciencia y la tecnología, http://www.dicyt.com/espanol
¿Cómo ves?, Revista de divulgación de la ciencia de la UNAM, http://www.comoves.unam.mx
Diario El País, Sección ciencia, http://elpais.com/tag/ciencia
Diario Público, Sección ciencias, http://www.publico.es/ciencias
DivulgaUNED, http://divulgauned.es
El Huffington Post, Sección ciencia y tecnología, http://www.huffingtonpost.es/news/ciencia-y-tecnologia
Investigación y desarrollo, Suplemento del diario mexicano La Jornada, http://www.invdes.com.mx
LatinAmericanScienceDotOrg, http://latinamericanscience.org/spanish
Naukas, Revista electrónica de divulgación, http://naukas.com
Red de Popularización de la Ciencia y la Tecnología para América Latina y el Caribe, http://www.redpop.org
Red latinoamericana de blogs de ciencia, http://redlbc.wordpress.com
Scidev.Net, http://www.scidev.net/america-latina
Scientific American en español, http://www.scientificamerican.com/espanol

Science Documentaries Collections

National Geographic en español, http://www.ngenespanol.com
RTVE.es, http://www.rtve.es/alacarta/documentales/cienciaytecnologia/
TED en español, https://www.youtube.com/channel/UCshVTOdmZLdLj8LTV1j_0uw

Other Useful Information Collections

LANIC, Latin American Network Information Center, http://lanic.utexas.edu