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# SCIENTIFIC

## THINKING MODEL THROUGH ENGLISH

## MODELO DE PENSAMIENTO CIENTÍFICO A TRAVÉS DE INGLÉS

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ABSTRACT

Besides providing theoretical and methodological background and tools for giving solution to professional problems, modelling scientific thinking and questioning should be one of the goals of any subject included in any university degree program. This does not exclude English, usually seen in EFL contexts mainly as a tool for communication and career development. This view has led to a contradiction among the priority conceded by the CES foreign language policy to English competence development, documented in the laws and regulations issued by this organism and the implementation of this legislation in the different universities. English, as any other language, is closely connected to thinking processes to conceptualize the world, thus it plays a great part in creating scientific language awareness and developing science literacy, which provides the basis for gaining knowledge of science content, understanding the world, society, and obviously, profession. This article presents the experience of using English for shaping students' professional competences through modelling scientific thinking and questioning in the frame of interactive collaborative work with other subjects. To explore the state of art of this research, the qualitative methodology has been used, which has led to establish philosophical, linguistic and didactic foundations for this proposal.

Keywords: Professional projects, project based teaching, language, thought, science.

RESUMEN

Además de proporcionar el fundamento teórico y metodológico y las herramientas para brindar solución a los problemas profesionales, modelar el pensamiento y el cuestionamiento científicos debe constituir uno de los objetivos de cualquier asignatura incluida los programas universitarios de grado. Esto no excluye el inglés, por lo general visto en contextos enseñanza de lenguas extranjeras (ELE) principalmente como un instrumento para comunicarse y hacer carrera. Esta visión ha conducido a una contradicción entre la prioridad concedida por la política lingüística del Consejo de Educación Superior (CES) en relación con el idioma extranjero al desarrollo de competencia inglés, ha documentado en las leyes y regulaciones emitidas por este organismo y la puesta en práctica de esta legislación en las diferentes universidades diferentes. El inglés, como cualquier otra lengua, está estrechamente vinculado con los procesos del pensamiento y con la comprensión del mundo mediante la conceptuación de la realidad. Consecuentemente, desempeña un gran papel en la creación de la conciencia y alfabetización científicas, que proporcionan la base para profundizar en el contenido de la ciencia, la comprensión del mundo, de la sociedad, y obviamente, de la profesión. Este trabajo presenta la experiencia en el uso del inglés para formar las competencias profesionales de los estudiantes mediante la modelación del pensamiento y el cuestionamiento científicos en el marco de trabajo interactivo colaborativo con otras materias. Para explorar el estado de arte de esta investigación, se ha utilizado la metodología cualitativa que ha permitido establecer los fundamentos filosóficos, lingüísticos y didácticos para esta propuesta. El aprendizaje basado en proyectos (PBL) ha constituido la plataforma metodológica principal para su puesta en práctica.

Palabras clave: Proyectos profesionales, enseñanza basada en proyectos, lenguaje, ciencia, pensamiento.

## INTRODUCTION

The idea behind this paper is to discuss the role of English in shaping the students' scientific thinking. For many years, English teachers have been trying to understand why, despite the priority conceded to English in the foreign language policies of many non-English speaking countries; it takes huge efforts to get space for English in the actual academic practice of the different programs and institutions. This shows an enormous gap between policies and their implementation and, at times, makes tiresome and time consuming our continuous search for improving the quality of the teaching learning process. After many actions and studies carried out in the search for adequate approaches, methodologies, and methods to improve our teaching practice in response to this contradiction, we have come to realize that this failure in achieving our communicative pursuit is, in many ways, connected to academics' and students' beliefs on the role of English in professional training. This gives us room to ground the idea about reinforcing the conception of English as a way of fostering scientific thinking tightly connected to critical thinking and to professional thinking as well, in face of the emergence of entrepreneurship and revalorization of entrepreneurial skills.

Foreign language learning is part of the overall development of any student. Taking English learning as a particular reference, it can be said that through learning English, the students can enrich their experience of life, broaden their world vision, and enhance their thinking skills. A quick look at the literature shows that the reflection on the development of scientific thought through English is neither fortuitous, nor new, although in this work it comes from countless questions we ask ourselves out in our teaching practice about the effectiveness and relevance of the teaching of English in the university, that has entailed the analysis of the academic community's perceptions of the role English language plays in their professional development in the university. The roots of this idea are well entrenched, from philosophy and sociology in Engels (1878), works on the role of language in the evolution of man, in analyses of the social character of language, reflected in the philosophy of language in the triad reality, thought and language (Figueroa, 1982).

Of prime importance is the contribution of psychology in the work of such classics as Vigostky (1954); Piaget (1954); Luria (1959) despite their contradictory viewpoints on this matter, to the understanding of the relationship between language and thought. Also based on their work of these authors Kuhn (2002); Chaille & Britain (2003); Lehrer (2007), have studied the problems related to the development of critical thinking at young age. Many of them have associated the treatment of this problem to such disciplines like mathematics, exact sciences, and engineering Root-Bernstein, Van Dyke, Peruski & Root-Bernstein (2019), this last paper makes an analysis of the correlation between the tools for thinking and arts and design avocations and scientific achievement of professionals of science, engineering, technology, mathematics and medicine (STEMM). However it must be taken into account that in the majority of the cases as Bylund & Athanasopoulos (2015), state, there has been an overwhelming tendency to investigate relationship between languages and thought through monolingual lens. According to these authors, the majority of papers exploring the role of the second language in cognitive restructuring (categorization, sorting, recognition and perception) deal with L2 speakers i.e. people who live in L2 settings and are exposed to L2 in a variety of contexts and situations on a daily basis. Subsequently, little is known about cognitive development through FL learning

### *Two non-excluding skills excluded in the real practice*

Knowledge seeking is a process of constant questioning of facts and evidence, of recurrent going back to the analysis of our thoughts and testing them against new facts and opinions, so it needs a combination of scientific and critical thinking as a complex unit. However unquestionable this could seem, not many teachers take account of this circumstance. Many tend to associate these two parts of the same unit to separate disciplines.

### *Scientific thinking*

For Kuhn (2002), scientific thinking is a form of knowledge seeking, which involves people in the process of finding out and making their own discoveries, instead of learning what other people have discovered and reaching conclusions allowing enlargement to their knowledge. This author argues that the requisite skills of conscious scientific thinking are the formation of a question or hypothesis, planning and conducting an investigation, analyzing the results, making inferences, and debating their implications.

Zimmerman (2007), in a broad definition of scientific thinking states that it includes the skills involved in inquiry, experimentation, evidence evaluation, and inference that are done in service of conceptual change or scientific understanding. They encompass thinking and reasoning skills supporting the formation and modification of concepts and theories about the natural and social world. She points out the recent increased emphasis on metacognitive and meta-strategic skills, and research on new opportunities for developing, consolidating and transferring such skills.

According to Dunbar & Klahr (2012), scientific thinking refers to both thinking about the content of science and the set of reasoning processes that permeate the field of science: induction, deduction, experimental design, causal reasoning, concept formation, hypothesis testing, among others.

As the intentional coordination of theory and evidence, whereby people encounter new information, interpret it and, if warranted, revise their understanding accordingly, see Liker & Rother (2018), critical thinking. What is important for them is that scientific thinking gives people the ability to look beyond own preconceptions and see the world more objectively, making possible to think about and reshape their own thinking in metacognitive processes.

These definitions have in common the view of scientific thinking closely connected to reasoning skills and processes, concept formation, inferring, hypothesizing, all of them resembling language processes. Quite generalized in current educational practice is the view on scientific thinking as a scholarly skill, usually taught from science, math, and engineering perspective. As contradictory it could seem, it is not common to find papers referring to language and scientific thinking, however it can be noticed that languages, native and foreign, are usually associated to critical thinking without realizing that these are two no excluding parts of the same reality, once scientific thinkers are critical thinkers.

### *Critical thinking*

Tightly connected to scientific thinking and attitude as well as to mind processes, critical thinking has to do with questioning, examining information and evidence, and evaluating them against owns beliefs through careful reasoning. Due to this, critical thinking enables us to analyze, evaluate, explain and reshape our thoughts, make decisions in a more reflective way.

Being considered one of the four Cs of the XX Century, together with communication, critical thinking has been subject to many books, papers and research Nardi (2017); Lin (2018); Katz (2018), presents a methodology for interpreting information, deconstructs common errors in thinking and teaches students to become a smarter consumer of research results. Ulrich (1995), refers to its role as contributing to enlightened societal practice, called to press environmental and social issues of our time and therefore it should be accessible not only to decision makers and academics, but also to the majority of people.

If we accept the fact that scientific thinking begins after the age of around 4 years, which children begin to understand that mental representations do not always duplicate external reality Kuhn (2002), and also the notion of young children as being naturally curious and biologically prepared to learn about the world around them Conezio & French (2002), then we should coincide with those, who consider that scientific thinking should be seen and taught as a life skill, and overcome the barrier preventing us from teaching this skill in such a way that makes is a permanent attribute, a skill for everyday life. Therefore, university EFL teachers should play their part in fostering students' scientific thinking through this subject.

### *Aim of the Study*

The paper aims at describing the role of English in shaping the students' scientific thinking through the analysis of two projects carried out in our teaching practice at State Technical University of Quevedo (UTEQ) with the participation of Systems Engineering students and elicit an answer to the following.

### *Scientific Question*

How to uncover the potential of English for developing future professionals' scientific thinking and give renewed meaning to the place of this language in our daily academic practice?

## MATERIALS AND METHODS

For this study mainly qualitative methodology was used, through action research. Based on the suggested by McNiff & Whitehead (2012), we designed an action plan that included proposing the project, reviewing our current teaching practices, applying a diagnostic test to identify the abilities with most difficulties at the given level, selecting the most suitable contents and tasks to evidence the potential of English to develop scientific thinking, monitoring the strategy in action through students' performance observation, questionnaire application, modifying aspects of our teaching practice, evaluating the students' progress through an integrative task completion.

### *Participants*

The participants were 150 students of Systems Engineering, between the ages of 18-20 and all taking English levels from 1 to 6 (between second and seventh semester) of their program, the majority with proficiency level between A1 and A2, due to the low level of exposure to language. Since this study claims that one of the reasons for the gap between the priority given to English in the country's linguistic policy with respect to foreign languages and the use of this language in the real academic practice, prior to running the action plan, a questionnaire was designed and applied to check the students' and

teachers' perceptions on the role of English in their professional formation. The questionnaire was applied using the Google platform and it included four questions related to the necessity of including FL, particularly English in the curriculum of university programs, the priority conceded to English in their programs, how they see English, and what learning English has allowed them. The results confirmed this claim, as shown in the charts (figure 1):


Figure 1. Priority of English.

299 participants out of 300 (99, 96%) consider necessary to include English in their curricular planning. However, the results showed differences in the answers to other questions. In relation to the questions 2 and 4 properly showing the perception of the role of English by the university community (figure 2), 186 participants (62%) believe that English has the necessary priority. To this percentage can be added those 53 people (17, 66%) who consider that English has more priority than needed. Only 41 participants (13, 7 %) think that English has less priority than needed and 11 people (3, 44 %) says that it has no priority. Summing up, only 42 out of 300 respondents feel that there's a need for more English in their professional formation.

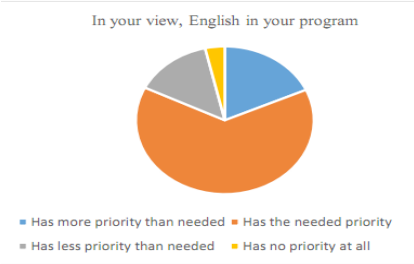


Figure 2. Perception of the role of English by the university community.

The views shown in the answers to question four, related to what English has allowed them, speak about the perception of this language mainly as a means of communication and a tool for understanding, but these results do not show awareness of this subject as a potential tool to develop scientific thinking (Table 1).

Table 1. Perceptions on the influence of English in respondents.

| The training received has allowed you | 1-4 | % | 5-8 | % |
|---|---|---|---|---|
| Communicate with other people using this language | 176 | 58,66 | 72 | 24 |
| Understand texts and audiovisuals in the language | 227 | 75,66 | 21 | 7 |
| Know other cultures | 135 | 45 | 124 | 41,33 |
| Develop your critical thinking | 52 | 17,33 | 206 | 68,66 |
| Increase your knowledge about your profession | 103 | 34,33 | 135 | 45 |
| Increase your motivation for scientific research | 31 | 10,34 | 197 | 65,31 |

This study preliminary study paved the way to the development of the proposal.

Two main stages for using English as a tool for modelling scientific thinking were considered: first direct English teaching practice. It should not be forgotten that, as any language, English has two main functions: noetic (cognitive), related to thinking processes, language as embodied verbal thought and a tool of knowledge building) and semiotic (communicative) related to reflecting objective reality and negotiating in your view, English in your program Has more priority than needed Has the needed priority Has less priority than needed Has no priority at all meaning. So, teaching English as a language for conceptualizing and understanding reality should be part of our teaching if we want to have success.

At this stage there are misconceptions to change; represented in the belief that scientific thinking has nothing to do with teaching beginners' levels. A quick glance at the ways the English textbooks we use at the university are organized, the sort of activities and materials they include evidence that, since they have been designed for a wider reader, they are not necessarily oriented to teaching scientific thinking, what does not mean that they cannot be used for that purpose. Nonetheless, many practitioners are prone to consider that at these levels it is not possible to teach scientific thinking through English.

When teaching beginners' levels construction of knowledge can be enhanced through social interactions that is, by encouraging them to share their observations and ideas with each other; the students should be stimulated to work together in building theories, testing those theories, and then evaluating what worked, what didn't, and why. To stop viewing our students as passive recipients of knowledge and to provide them with varied opportunities for knowledge construction and constant testing of their beliefs is a condition sine qua non to foster scientific thinking.

One way to involve the students in shared inquiry is through having them solve problems using procedures related to scientific reasoning, concept formation, and following the stages and principles of the scientific method, when adequate. The emergence of communicative approaches for FL teaching, focusing on the communicative language function in response to traditional approaches at times has led to underestimate important elements helping to understand other important functions related to the cognitive potential of language. If we examine the way we teach vocabulary, for example, we will discover that we focus mainly on meaning and usage but it can be useful to stimulate students' curiosity to etymological aspects of some words, or to word motivation, facilitating understanding.

For example, it has proven easier to understand family related words when teachers explain that their motivation comes from the source providing them, than when teachers just present the word in context or using technology without guiding their curiosity to peculiar aspects of this vocabulary.

The second moment in using English for developing scientific thinking is involving students in real scientific projects relating English with professional disciplines.

### *The projects*

The first project involved 150 students if the six levels in developing one theme: similarities and differences between American and Ecuadorian people. They were organized in teams of four or five students. Some teams distributed units among their members, for the searching of information.

The **rationale** given was the following:

***There's a tendency to believe that English speaking people and Spanish speaking people have more differences than similarities. However, in face of the current movement to integration and communication among different people, it becomes very important to know what makes us different and what makes us similar.***

The statement to be tested was: There are more things bringing us together than those separating us:

Task 1. Take a trip throughout the subject content and, based on the topic of each unit find the similarities and differences between American and Ecuadorian people.

Task 2. Write a short essay about on the topic: American and Ecuadorian people what brings us together, what separates us.

They had to come up with a strategy to do this project, to distribute the different tasks and responsibilities, to review sources to gather information. They had also to apply search skills. They ended up presenting interesting essays about their findings on the topics reviewed.

The second project consisted in using the students' knowledge of Programming to develop a tool for studying English. The results of this project were presented by the students themselves in a workshop on Best English Practices at UTEQ, with the participation of other English teachers. The students systematized the content of their subject and created a tool for studying English on the basis of their textbook. Besides they were given the task to add videos and other materials they would consider for complementing the contents.

In both projects, the focus was not only on content competency development, but also in motivating curiosity, creativity, and above all, in having the students question their beliefs on the given topics, through critical thinking and reasoning, support to scientific thought.

## CONCLUSIONS

As one of the main findings of this study it can be said that the beliefs of academic and student community on the role of English in their professional formation lay under the gap between the priority given to English in the foreign language policy of Ecuadorian CES, and its implementation in the real practice.

One of the ways of fostering scientific thinking through the use of English is getting the students engage in tasks and projects constantly putting under questioning their beliefs, conceptualizing, and eliciting the necessity of applying steps, which reproduce the scientific process, such as problematizing, hypothesizing, supporting ideas, applying dictionary and search skills, and finally organizing strategies and modelling solutions.

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