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Cross-Disciplinary Lessons in an Elementary Public Institution

Lecciones interdisciplinarias en una institución pública de básica primaria

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This article reports the results of an action-research study, carried out in the fourth grade of a Colombian public elementary school, which sought the integration of the teaching of English and the natural sciences through cross-disciplinary lessons that followed the principles of content-based instruction. Observation, action plan, and evaluation were the ongoing research stages. Interviews, workshops, and the students' portfolio were the main instruments used to collect data. Results revealed that the cross-disciplinary lessons were appropriate and useful to connect the foreign language learning with other school subjects. Beginner students of English demonstrated an enhancement in the communicative skills and developed contextualized learning strategies, which proved the importance of integrating English with scientific contents as a contribution to curriculum innovations.


Keywords: content-based instruction, cross-disciplinary lessons, foreign language teaching and learning, public school, sciences curriculum

Este artículo reporta los resultados de una investigación en el aula, realizada con un grupo de cuarto grado en una institución educativa pública colombiana, cuyo propósito consistió en integrar la enseñanza del inglés con el currículo de ciencias naturales mediante un conjunto de lecciones interdisciplinarias siguiendo el enfoque basado en contenidos. La investigación se desarrolló en tres etapas: observación, plan de acción y evaluación. La recolección de datos se realizó mediante entrevistas, talleres y portafolios. Los resultados indican que las lecciones fueron apropiadas y útiles para establecer una relación interdisciplinaria entre los temas de enseñanza. Los estudiantes demostraron habilidades comunicativas y estrategias contextualizadas, mediante las cuales se constató la importancia de integrar el inglés con contenidos científicos como una contribución a las innovaciones curriculares.

Palabras clave: aprendizaje basado en contenidos, enseñanza aprendizaje de una lengua extranjera, escuela pública, currículo de ciencias naturales, lecciones interdisciplinarias

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This paper presents final results of the research project titled *Transformación de las prácticas pedagógicas universitarias mediante la investigación-acción en el aula* (Transforming higher educational practices through classroom action research), sponsored by Vicerrectoría de Investigaciones, Universidad de Caldas. Code number VIP 0934815.

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Introduction

Cross-curricular practices can be of great importance in educational settings provided there is a smooth integration among the different fields of study. Such integration has to do with pushing the boundaries of disciplines to have access to a broader meaning and understanding of scientific knowledge. Furthermore, integration offers relevant learning opportunities that facilitate less fragmented experiences by making meaningful links between content subjects and other related fields of knowledge.

Integration has provided many public and private institutions with a viable alternative to attain innovative changes in the classroom, covering the overarching disciplines, including those that will help the new generations of professionals to face a new society characterized by emergent issues such as collective intelligences, collaborative work, the crises of the planet, robotics, networks, communicative competences, and so on. For this reason, in the field of education, new interdisciplinary methodologies are required to meet the complex and dynamic profiles that arise as time progresses.

In the two initial decades of the 21st century, in response to the changing academic reforms, Colombian universities are also considering cross-disciplinary competences that would give pre- and in-service teachers a better pedagogical background than traditional professional careers (Ministerio de Educación Nacional [MEN], 2016; UNESCO, 2014). Teachers are challenged to solve practical pedagogical problems by using and integrating knowledge generated from root disciplines and different academic subjects in order to reach curriculum goals. Already during their undergraduate stage, students should acquire more cross-disciplinary knowledge which they could later apply to their professional development. Nonetheless, according to national policies, some subjects are integrated more often than others and the typical separation between different areas of study, which are

unconnected, fragmented, and disjointed, is frequently discussed.

A call for the transferability of cross-disciplinary trends in response to the ongoing curriculum reforms is a national policy established by the MEN as an indicator of improvement and high-quality accreditation both in basic and higher education. All of this and more underpins the idea to do a careful analysis of the integrative approaches to delve deeper into the renewal of teaching and learning methodologies. According to current national languages policies (MEN, 2016; Usma-Wilches, 2009; Zwisler, 2018), educators, institutions, policy makers, stakeholders, and bilingual programs are expected to examine why, how, and to what extent different curriculum subjects can be integrated.

Concerning the ongoing Colombian bilingual programs, since the 1980s, English has become the most prominent foreign language thanks, in part, to governmental policies that regard this language as fundamental to have access to the competitive worldwide markets (Bonilla-Carvajal & Tejada-Sánchez, 2016; Gómez-Sará, 2017; Zwisler, 2018), as well as an instrument to construct and disseminate scientific knowledge. Following the recommendations from the Common European Framework of Reference for Languages (Council of Europe, 2001), it is expected that, by the end of their secondary education, all students should have acquired the necessary skills to be proficient in, at least, one foreign language (especially English).

As a consequence, the most recent curriculum reforms (McDougald, 2016; Usma-Wilches, 2009) in all the territory at all educational levels provide specific methodologies, assessment, and evaluation guidelines that teachers should apply in their classes, considering that traditionally, the foreign language has been taught as a separate component in a decontextualized way.

Among different strategies for the teaching of the foreign language in elementary education, the MEN (2016) clearly recommends all types of integrative methodological routes, such as content language integrated

learning (CLIL), content-based instruction (CBI), total physical response (TPR), action research, case studies, task-based learning, and so on. Moreover, the national curriculum proposal embraces transversal themes for each elementary grade with goals, objectives, contents, and functions of the language. Taking into account the specific cultural contexts, the teachers of English can adapt a variety of cross-curricular topics: healthy life, coexistence and peace, environment and society, global village, among others.

Based on the previous considerations, we wanted to explore how CBI may facilitate the teaching of a foreign language (in our case, English) through cross-disciplinary lessons, with the natural sciences as the core curriculum. The following question guided our study: How can the principles and method of CBI be integrated into the foreign language classroom by taking the natural sciences as the core curriculum content to design cross-disciplinary lessons in a public Colombian institution?

Consequently, the following objectives were posed:

- To establish the relationship between the teaching of English as a foreign language with the natural sciences as the core curriculum by applying the CBI approach.
- To design cross-disciplinary lessons as an innovative strategy in order to link the real context of the students with their language learning.
- To promote different English language skills through the implementation of research processes as a learning strategy inside the language classroom.

Literature Review

The most recent trends look in more detail at the concept of cross-disciplinary endeavors, so that the new generations can meet the challenges of the third millennium (UNESCO, 2014). In the Colombian educational system—elementary, secondary, middle, and higher education—there is increasing alignment

with the purposes of playing a pivotal role in understanding curriculum development as a holistic arrangement.

Integrating different curriculum areas into the foreign language topics is one of the most innovative strategies to improve the quality of teaching because it is a great opportunity to increase subject knowledge simultaneously. Some educational institutions are starting to design cross-disciplinary lessons as a means of working different subjects (i.e., social sciences, math, environmental education, technology, art, tourism, etc.) through English (Leal, 2016; McDougald, 2016; Vega & Moscoso, 2019).

The Content Based Instruction Approach

Authors like Grabe and Stoller (1997), Heidari-Shahreza (2014), McDougald (2016), and Stoller (2002), amongst others, have argued that the CBI approach, through cross-disciplinary strategies based on real content, favors communicative language teaching inside the classroom. Thus, language performance is so heavily influenced by the purposes for which both teachers and students are working in class.

The abovementioned authors list the following main premises behind the CBI trend which can help design cross-disciplinary lessons:

- The CBI approach is considered as an innovative tool for teachers to integrate the linguistic aspects with meaningful content knowledge.
- CBI is a context-driven approach and is very much centered on what the content can offer to students and how it is developed through the language; that is, the language is taught in a contextualized way.
- Teaching by using CBI can develop the critical and reflective thinking of students because they are aware of the kind of topics on which they are working. Students play an active role and keep motivated to learn the foreign language.

- The teacher can easily provide information on the specific matter being taught in the language being learned.
- Generally, the topics are contextualized and interesting, and the students learn them in an innovative, interactive, and communicative form.
- Students acquire different language skills through several kinds of strategies which go beyond the morphological and syntactic aspects of the language.
- Cross-disciplinary lessons integrate the students' previous knowledge and experiences as relevant background to begin each lesson.
- The CBI approach offers relevant implications for incorporating assessment alternatives in the language classroom such as introducing meaningful content in the student's foreign language learning.
- In CBI, learning and teaching are centered on the students' interests and needs. For this reason, the existing pedagogical methodologies, thematically organized materials, and didactic strategies are to be periodically updated and adjusted in order to create a more learner-centered classroom.
- By working together, both content and language teachers interact in selecting, planning, implementing, and evaluating the most suitable kinds of successful tasks for their learners.

The Natural Sciences Curriculum

Education in natural sciences and the environment is one of the main curriculum subjects taught in all public and private Colombian schools, according to the national policies of the MEN. Biology is integrated more often than other school subjects (Tokar & Koch, 2012); sciences present a high number of scheduled hours during the year and is the second most popular subject in Colombian bilingual schools, especially in private ones, which are increasingly doing the most with English and content (McDougald, 2016). These subjects make it possible for students to get familiar with phenomena in the natural world and with the physical, chemical,

and biological processes that affect the environment. Furthermore, to develop environmental awareness in students, it is important that they are given the opportunity to gather some basic knowledge related to the mechanisms of all living creatures, including humans.

Currently, teaching natural sciences in the school curriculum is a demanding task due to the new strategies proposed for the entire educational community. There is a worldwide concern for the environment and global warming (UNESCO, 2014) and, therefore, some educational institutions, especially at primary and secondary levels, are implementing environmental projects in order to motivate the students to help take care of the planet. Health risks, poverty, pollution, climate change, endangerment of species due to exploitation of fauna and flora, and even the socio-environmental conflicts of the communities are critical phenomena having a negative impact on ecosystems (C. A. Munévar-Quintero et al., 2017).

Thus, integrating English and sciences simultaneously is considered as an innovative curriculum experience to enrich the educational literature review concerning foreign languages acquisition (Tokar & Koch, 2012; Zirilli, 2019). It is important to highlight the importance of English as an effective vehicle for students to have access to more information on the natural sciences, demonstrating how public institutions can link the gap between topics that go hand-in-hand: language, natural sciences curriculum content, education, and policy.

Nowadays, English is gaining prestige as a vehicle for knowledge transmission, which, arguably, can make the learning of this language appealing to students. English within the natural sciences curriculum becomes convenient for students to understand and for them to talk about scientific concepts in a contextualized way, including a variety of engaging scientific aspects (such as states of matter, physical and chemical properties of matter, etc.). It is evident that foreign languages curriculum programs need to leave behind some traditional methods, providing teachers with a real-

time answer that is context driven because they have to be competent for implementing the most innovative teaching strategies.

Previous Studies

Tokar and Koch (2012) examined influencing factors concerning the use of integration as a teaching method into an undergraduate program. They previously compiled numerous contributions of integrating root disciplines such as natural sciences, physical sciences, social sciences, and humanities, among others. The most dominant obstacles hindering integration seems to be:

- lack of textbooks and handbooks,
- lack of time for scheduling integrated activities, and
- poor preparation during undergraduate studies, since teachers are not competent enough in combining different school subjects.

The results revealed that classrooms offer plentiful conditions for integrating social sciences, natural sciences, and humanities. For instance, to apprehend basic concepts of natural phenomena, students and teachers would be able to explain some root knowledge concerning the laws of physics, chemistry, biology, as well as mathematics. The ability to integrate school disciplines is in positive correlation with teachers' interest and background and demands strong cooperation between them.

Along the same lines, Chou et al. (2019) carried out an experimental cross-curriculum reform whose main purpose was to design a self-adjusting learning strategy for preservice teachers. These authors consider that it is urgent to introduce self-adjustment mechanisms of inter-disciplinary teaching professionalism to provide a clear definition of the graduate skills according to specific characteristics of the regional areas and the job markets. In this commitment, teachers play an increasingly important role in curriculum reforms due to their know-how in organizing and integrating the

required academic subjects to cater to the local and regional needs.

In a most recent study, Chuku (2020) identified resultant benefits after applying numerous skill strategies for developing environmental topics while teaching English through CBI, considering that the global environmental degradation is a grave situation affecting populations. Thus, today's warming, deforestation, natural disasters, and water pollution were selected as "green" content integrated learning with English. She stated that environmental issues stimulate the improvement of both discrete and integrated skills in process- and product-oriented curriculum projects. For this author, countless issues around the world, which can be incorporated into language classrooms, especially by using CBI, are sparking the interests of both learners and teachers.

Chuku (2020) designed classroom integrated environmental lessons taking into account the students' previous knowledge, age, and language skills. Students were able to increase pertinent vocabulary, oral responses, reading and speaking activities, paragraph patterns, paragraph-writing tasks, skimming, scanning, note-taking practice, and other linguistic abilities. These exercises provided meaningful language use and facilitated authentic communication. According to Chuku, teachers understand the value of CBI for improving students' meaningful language and content instruction while debating environmental topics.

Zirilli (2019) conducted a bilingual case study applying CLIL to teach a non-linguistic topic focused on natural sciences. The participants were a small group of sixth graders from immigrant families. Despite certain curriculum limitations, the science teachers observed a high level of participation and motivation when students developed cooperative and experimental classroom activities favoring the acquisition of skills and abilities during the process of using the foreign language (English) as a vehicle for content learning.

Leal (2016) selected a natural science class with third grade bilingual students to conduct a small-scale study using the CLIL approach, bearing in mind that it was urgent to provide information on specific aspects concerning the effectiveness of the program. The researcher adjusted an assessment grid aimed at reporting students' achievement in terms of content and language demands of test items validity. Through the assessment grid, CLIL teachers would be able to observe and understand distinctly students' difficulties and strengths as well as to attend to their needs.

Method

This study is based on the principles of the classroom action-research approach which helps teachers develop their scientific skills while they improve their teaching contexts through reflection and inquiry (Kemmis & McTaggart, 1995; Kunlasomboon et al., 2015; Wallace, 1998). It is a cyclical process involving observation, planning, experimentation, and identification of critical points to improve real situations inside the classroom or other social environments by participants themselves.

For this study, action research seemed an appropriate choice because we wanted to encourage both teachers and students to participate in some version of that process of reflection and inquiry that is often reserved for the researchers. In this case, a sequence of four natural science lessons was planned using the foreign language (English).

Context and Participants

According to the Institutional Educational Project, the school was created by a Catholic community and, for this reason, it is deeply rooted in spiritual and religious values. It is located in a little town near Manizales (Colombia), a medium-size city in the center of the country. Students come from low- or middle-income families and are involved in different social, charitable, and inclusive celebrations or activities. Likewise, the institution has several concerns as it

cares for the environment and the students' health and lifestyle. For these reasons, the importance of teaching natural sciences contents, including environmental education, is paramount. As a result, the institution organizes this subject in curriculum units of learning, each one with a different main theme. There are four units for each of the two academic periods in the school year. The first main teachable contents and topics are: living environment, physical environment, physical processes, chemical processes and science, technology and society.

Furthermore, the Environment School Project and the Healthy Lifestyles Project are the two most influencing projects at the institution that permit students to transfer the knowledge acquired in the classroom. Students learn about the importance of water as a non-renewable resource, the role animals and plants play for maintaining balanced ecosystems, as well as the human practices that have a positive environmental impact such as recycling, reducing and reusing waste. Additionally, students learn about the maintenance of a daily diet and the need for eating healthy food. A vegetable garden is located on the premises at the back of the school where the students, with the help of their teachers, sow different kinds of plants. The participants of this study were 38 fourth-grade girls with ages 9 and 10 years.

The following team of experts was in charge of the creation of the cross-disciplinary lessons by applying the core principles of the CBI approach in the English class:

- A preservice teacher from the Modern Languages program playing the role of research assistant during her practicum stage. She is one of the authors of this paper.
- A practicum advisor to the preservice teacher who guided the whole research process, including the fieldwork, observations, evaluations, and the final report. She is one of the authors of this paper.
- A natural sciences teacher who facilitated the theoretical contents and the didactic materials for the researchers.

- An English head teacher who expressed strong concerns about the official curriculum guidelines. He observed the effect of the cross-disciplinary lessons and helped the preservice teacher to understand the school life during her practicum stage.
- A PhD student in the process of developing her doctoral thesis. She holds a BA in biology and chemistry, and was able to provide theoretical, scientific, didactic, and methodological guidelines concerning the natural sciences curriculum. She is also one of the authors of this paper.

Stages of the Research

First Stage: Observation

We carried out a series of observations during the first month of the academic semester to collect information on the institutional context and the methodologies, didactic resources, bibliography, and classroom environment in the English and natural sciences lessons. Semistructured interviews in Spanish were useful to collect participants' impressions before and after the action stage and then, the answers were translated into English. Additionally, we reviewed the school's constitutional principles, the English and natural sciences curriculum, and other educational documents to help us find the most suitable approach to teach English, and more importantly, to give shape to the cross-disciplinary implementation. We found that integrating natural sciences with the teaching of English seemed to be a motivating alternative to get students involved in different activities through classroom projects.

The preliminary results, taken from the observed classes, helped us to justify the design of CBI and to select the appropriate didactic materials for the forthcoming lessons. Checking some students' notebooks and the existing English curriculum, we confirmed that: (a) lessons were 99% in Spanish, and thus, the use of English was very limited, inside and outside the classroom; (b) vocabulary and grammar aspects were

memorized through sentences or in short dialogues without a specific context; (c) students translated every word into Spanish; (d) although teachers used flashcards, videos, and gestures to help students understand, this was not done regularly; (e) most English content was isolated and did not deal with real situations related to the students' context.

During this preliminary stage, teachers were interviewed about the frequency, reasons, rank, and type of disciplines they integrate into school courses. The respondents considered that academic subjects are rarely integrated. There are areas that the institution often ignores when considering how to integrate learning tasks whether totally, partly, or even nothing at all. Nonetheless, a few given options were mentioned concerning natural, physical, and environmental sciences:

When a teacher explains the interconnection between cause and effect for a certain phenomenon. (Teacher 1)

When teachers conduct practical tasks and demonstrations in the classroom or in the lab. (Teacher 2)

When students carry out physical experiments inside or outside the classroom. (Teacher 3)

When the academic community organizes institutional events which requires mutual cooperation, for example, the Science Fair, technology expositions, drug consumption. (Teacher 4)

My colleagues normally combine mathematics with biology, chemistry, and physics. On the other hand, philosophy, geometry, geography, Spanish, literature, mathematics, and language topics are less frequent. (Teacher 5)

One of the interviewees also pointed out that meeting cross-curriculum teaching goals is a very difficult task which implies a huge effort and sacrifice as well: "My opinion does not mean to dismiss the reputation of the construction of complex knowledge, but rather to recognize that we are used to working in isolation" (Participant 2). Bearing in mind that integration of

academic subjects is not easy to put into practice, Participant 6 added:

It is safe to say that teachers at the school currently overcome serious obstacles when undertaking transversal projects or they do not receive the necessary attention. This concern is often repeated by colleagues in our own, day-to-day schooling practices.

Second Stage: Action Plan and Implementation

Four cross-disciplinary lessons were designed by the team of experts (the English teacher, the science teacher, the preservice teacher, the practicum advisor, and the doctoral student) applying CBI, for the school period, during one semester. The lessons were based on the same topics arranged in the natural sciences curriculum. Some of them were: forms of energy; states of matter; pure substances and mixtures; mass, shape, and volume; chemical changes; and lab experiments such as measuring, weighing, combining, heating, cooling, and so on. The classes were carried out by the preservice teacher, but the science teacher was present helping to develop the experiments and clarifying scientific concepts in Spanish when students asked for explanations.

Each of the cross-disciplinary lessons included a structure divided into eight sections, as shown in Table 1: (a) topic, (b) linguistic objective, (c) communicative objective, (d) warm up, (e) presentation of the topic, (f) practice, (g) production, and (h) evaluation. The lesson shown in the Appendix is a sample selected from the total set of the four classes.

Third Stage: Evaluation

The whole team was able to assess and evaluate the effectiveness of each of the four implemented lessons and made suggestions, comments, and annotations. Also, the research group interviewed the English teachers, the natural sciences teacher, and the academic coordinator. They described and valued in detail the advantages and

disadvantages concerning the implementation of the CBI methodology, taking the natural science curriculum as the core content. Also, the preservice teacher made self-evaluations related to her classes through descriptions, interpretations, proposals, and reflections of issues on the most relevant aspects found. The English head teacher observed the class and provided feedback with recommendations to improve the lesson plans.

Workshops, worksheets, drawings, photos, illustrations, videos, original tasks, and portfolios were the main instruments and techniques used in the data collection procedure. One of the alternative assessment practices used in CBI is portfolio assessment (Delett et al., 2001), since students are able to observe, recognize, reflect, and be aware of their mistakes and achievements, as well as their weaknesses and strengths. Portfolio assessment can develop both critical thinking and communicative abilities in the language acquisition process.

By Lesson 2, students were starting to become familiarized with the dynamics of the lessons. They were expected to draw a characteristic of each season. Students sang the song “Sun Little Sun.” The preservice teacher asked about the North Pole. The students saw a video about the states of matter. She asked questions about the video: What the three states of the matter are, how the particles act in each one, and what a particle is. She explained what an atom is and how it is transformed in each state. The students named which state of matter can be found in each period and how these show up in each season. For example, in winter the ice is solid, and people wear hats, gloves, and coats. In spring there are flowers and the ice melts, so it becomes liquid. In the fall season the leaves fall down from the trees. In summer the sun, the sea, and so on.

The students pasted images in the correct season. Divided into small groups, they did word-search puzzles using the vocabulary. Four images related to the topic season were drawn and the students had to paste any kind of grain, candies, or another element to represent

Table 1. Topics, Objectives, and Resources of the Integrated Lessons

Topic	Linguistic and communicative objectives	Scientific vocabulary and grammar structures
Lesson 1: Going to the science museum	<p>To identify the vocabulary about forms of energy.</p> <p>To recognize the demonstrative adjectives.</p> <p>To talk about a science museum.</p>	<ul style="list-style-type: none"> • This is a magnet • That is the sun • Those are manmade objects • Classify these objects: candies, beans, rice, oil, sugar, cereals or grains, a powered juice, a bottle of water • Paint a science museum • What are the forms of energy? • Don't waste energy • The guitar produces sounds • The sun produces light and energy
Lesson 2: The states of matter	<p>To identify the vocabulary about the states of matter.</p> <p>To talk about the North Pole.</p>	<ul style="list-style-type: none"> • How many seasons are there? • Describe a characteristic of each season • Draw the states of matter • What is a particle? • Is ice solid? Is water liquid? • Are there flowers in spring? • Paste images in the correct season • This is the water cycle
Lesson 3: Let's cook a chocolate cake	<p>To identify the vocabulary about the mixture.</p> <p>To talk about cooking a chocolate cake.</p>	<ul style="list-style-type: none"> • Put the candies in the glass • Stir in sugar and butter • Observe the mixture • Can you separate sugar and butter? • The juice of the lemon dissolves in water. Can you separate it? • Write the recipe of the chocolate cake • Count the minutes of oven use • I do not like chocolate, I prefer fruits
Lesson 4: Let's go to a shopping center	<p>To select the vocabulary about the specific properties of matter.</p> <p>To talk about going shopping.</p>	<ul style="list-style-type: none"> • Do you eat fruits? I eat fruits every day • Do you like soda? Yes, I do. • Describe the chemical properties of matter (air, acid, base, water) • Describe the physical properties of matter • Metals are solid. Water is liquid. Carbon is black • Is volume a physical property? Is combustion a chemical property? Is gas a physical change? Is temperature a physical change? • What is an atom? The nucleus contains protons and neutrons • Physical properties include: texture, color, odor, volume, temperature, density, mass, volume, length, and shape • How many pounds of sugar do you need?

each state of matter. Finally, students created an atom with Play-Doh and labelled all the parts in English. Some students presented their work in front of the class. They really enjoyed the activity and designed some creative works within the planned time. In the interview, students expressed opinions like “It is fun,” “It was too easy, teacher,” “I love making drawings,” “I understood the science class.”

In Lesson 3, where students worked on cooking a chocolate cake, they were enthusiastic about the topic because it clearly responded to their likes and their family context; some students expressed that they usually did this activity at home with their mothers. The students brought the material asked for by the preservice teacher in the previous class (candies, beans, rice, water, oil, sugar, etc.), to teach them how to prepare a snack. Students started by putting these ingredients in a glass and they stirred them. In this way, students experimented that this mixture could be easily separated. Later, students took a glass with water, squeezed a lemon in it, mixed a spoon with sugar and stirred it. Immediately students noticed that the sugar and the lemon juice dissolved in the water and could not be separated. The preservice teacher introduced a video in which different types of mixtures were explained. Using a clock, each student wrote the recipe of the chocolate cake with its different ingredients as well as the time it took to bake the cake. Each student classified the recipe into homogeneous mixtures and heterogeneous mixtures.

Students were very happy and some of them said that they enjoyed cooking at home with their mothers. Some students uttered short sentences in English such as: “I love chocolate cake,” “It is delicious,” “I love cooking.” Long sentences were uttered in Spanish and translated by the head teacher or by the preservice teacher: “The activity was different and funny,” “I am able to explain my mother how to make a chocolate cake.” *[sic]*

In Lesson 4, students played a game called “apple lemon.” The girl who has the lemon when one classmate says “lemon” has to create a phrase using vocabulary

related to matter and time. The students saw different objects on the desk, simulating a shopping center. After that, they drew and colored each object and described their specific properties. The girls created a short dialogue about the physical and chemical properties of matter. Students really enjoyed the activity and acted as if they really were at a shopping center. At the end of the lesson, they uttered emotional expressions such as: “Thank you, teacher!” “The exercise was fun,” “It was a great class.”

Three English teachers, the science teacher, and the academic coordinator were interviewed after this stage. They recognized the value of integration. The head English teacher said that “through CBI it is possible to elicit interesting ideas about the experiments. I observed that the preservice teacher prepared error correction exercises. The most common mistakes were focused on grammar, spelling, pronunciation, and sentence structure.” The science teacher argued that it is imperative to update the obsolete textbooks and handbooks “which undoubtedly do not include plentiful guidelines for cross-curricular lessons.”

In addition, interviewees made some comments which are highly relevant for both science and language teachers’ education in the future. They mentioned three other factors which hinder integration: student age (too young), limited hours of school courses, and lack of know-how among teachers. Another opinion, a negative one, was that teachers feel that they are not prepared enough in these cross-curriculum competences: “Most teachers at elementary institutions do not speak English and they do not know how to integrate some relevant subjects” (academic coordinator). Lastly, the interviewees pointed out that novice foreign language teachers are more frequently engaged in cross-curricular practices while the more experienced ones usually lose interest in this sort of approach. Finally, the academic coordinator commented the following:

Many of today’s teachers in my school understand the importance of integrating curricula subjects; nonetheless, this essential task depends predominantly on their

professional preparation, personal interest, and work experience. [For this reason] it is necessary that the university reinforces the ability to integrate disciplines as the one that we observed through this interesting CBI project.

Results

We identified some useful information after evaluating the effects of the implementation of the cross-disciplinary lessons. For instance, the advantages and disadvantages of using the morphological and syntactic structures of English to facilitate the learning of natural science topics. During the development of the lessons, the students demonstrated basic communicative skills by using the foreign language with the CBI approach. We observed how the students started to use basic utterances in the foreign language to interact with their classmates and to somehow frame their comments and thoughts around the specific topics pertaining to their science class.

Students were able to put into practice some grammar structures, technical vocabulary, and scientific concepts, which were used to integrate communicative skills. Motivation was evident, as a result of implementing contextualized activities. Participants showed interest in the content classes and demonstrated more engagement in the evaluation sessions which allowed them to become more involved in the activities performed during the whole process.

Meaningful, integrated, and contextualized activities generated in the students an evident higher participation during the classes. This participation was supported by the use of the language through science contents and integrated strategies. It was imperative to take into account that the idea of learning and teaching was centered on the students' interests, needs, and previous knowledge. To reach such a goal, the team of experts was in charge of updating, adjusting, and evaluating the existing pedagogical methodologies and didactic

materials. The natural sciences topics, such as states of matter, properties of matter, mixtures, and so on, and the didactic materials served to improve quite effectively the students' language learning and acquisition.

Through contextualized and family activities such as visiting a supermarket, observing the climate (a rainy and cloudy day), ice cubes in the refrigerator, and cooking a chocolate cake at home, participants demonstrated a high level of interaction at the moment of doing natural sciences activities through workshops inside and outside the English class. Students were also able to help their partners when they participated in class so that they felt comfortable, which created an adequate learning environment for all.

Discussion

Although previous research studies carried out in Colombian educational settings (Fandiño-Parra, 2013; McDougald, 2016; Usma-Wilches, 2009) confirm that students, especially in public institutions, perceive the learning of a foreign language as a difficult and complex matter, it is possible to design cross-disciplinary language classes centered on students' interests and needs, and putting into practice meaningful and contextualized learning. Cross-disciplinary lessons become convenient for students to understand and use the foreign language in a communicative way as well as talk about issues related to other disciplines, even in some basic way.

In line with the research carried out by Chuku (2020), as a matter of fact, the CBI approach through cross-disciplinary lessons can help students to connect their previous knowledge (in natural sciences, in this case) with new subject matters. Students acquired the capacity to express their previous and new information by using English grammar structures and specific terminology for scientific curriculum contents.

It is noticeable that Colombian education requires new perspectives towards the teaching-learning of the English process moving away from the traditional classroom methods centered on memorizing isolated

vocabulary and mechanic repetition which are not put into practice immediately. Those practices seem to have been used in most public schools until now. In this sense, the interdisciplinary content-based lessons, proved in this study, became an effective proposal to contribute to addressing crucial necessities identified by the MEN (2016): the need to train qualified English teachers, especially for elementary levels; lack of didactic and contextualized resources; few number of hours scheduled in public institutions; lack of collaborative teaching groups able to integrate isolated disciplines inside the school curricula; among others. As McDougald (2016) suggests, both teachers and students need to recognize how content and language go together.

Bearing in mind that in Colombia there are many families with limited financial resources, we took advantage, using our experience, of affordable didactic materials that could be adapted and used in other similar school contexts. With these relevant curriculum contents, participants in public low-budget schools may be able to create their own worksheets, workshops, and other interesting activities in a meaningful and pleasant way as long as the English teacher presents relevant and contextualized topics.

It is true that Latin America, as all other regions in the world, is facing the worldwide impact of globalization and technology (F. I. Munévar-Quintero, 2014). Among other things, this is the reason why English is turning into the most powerful and privileged language integrated inside the curriculum reforms according to the most recent educational policies enacted by the MEN (2016). Nonetheless, Leal (2016) argues that little research is done on the use of integrated learning inside the classrooms. As a result, the methods and strategies to learn and teach English have to be updated to different and more complex aspects enriching the educational literature review.

CBI becomes a pertinent methodology to train new teachers at university, providing them with a real-time answer that is context driven because they have

to be competent for implementing the most innovative teaching strategies, where young generations face the challenge of cross-disciplinary work integrating updated issues such as the crisis of the planet, technology, digital intelligences, and global warming, among others (C. A. Munévar-Quintero et al, 2017; UNESCO, 2014). At the same time, graduates would be able to provide practical solutions to the urgent requirements concerning the Colombian English classrooms, particularly in elementary and basic public institutions.

As current teaching formation programs have to prepare new teachers in innovative strategies inserted in the latest tendencies (Chou et al., 2019; MEN, 2016; UNESCO, 2014; Zwisler, 2018), this classroom action-research project may be seen as one of these. It is necessary for the English teachers to be more creative not only in implementing methodologies but also in the ways of evaluating and looking for students' progress. Thus, we are left with the following question: Can CBI help new teachers to transform traditional methodologies used in the English classes? Of course, it is possible to qualify education programs by linking the gap between teaching methods and cross-disciplinary content-based approaches. In short, this action-research project presents a cross-disciplinary proposal aimed at innovative educators (not only English teachers) who are open to new challenges and are prone to work towards integrative perspectives that the academic community repeatedly attempts to achieve.

Conclusions

As a response to the research question, the CBI approach was successfully integrated into the foreign language classroom by taking the natural sciences as the core curriculum content through a set of cross-disciplinary lessons which were designed and adjusted in a public Colombian institution. There is a direct and strong relationship involved in the teaching of English as a foreign language with the natural sciences. The

starting point of this action-research project was the identification of the problem area demonstrating the necessity of the English curriculum in a Colombian setting, in this case, the fourth-grade class of an elementary public school. Next, it was necessary to modify several didactic and pedagogical aspects through the design of some interdisciplinary lessons based on CBI, in order to lay aside the traditional methodologies implemented in the language classroom.

After analyzing the results emerging from this classroom action-research project, it is important to conclude that the CBI approach offers effective pathways to integrate a meaningful context with the learning of a foreign language in public low-budget schools. It is evident that English teachers can include different strategies, methodologies, and techniques to improve their classes and leave behind some current and real issues of the traditional educational institutions, and thus help students work in a didactic and integrative way by using scientific contents.

Designing and creating new strategies and methodologies make the learning of English easier. For this reason, cross-disciplinary lessons in the natural sciences curriculum include a variety of engaging and captivating topics suitable for learning different unknown scientific aspects about students' science, environment, and academic tasks. Students seem more motivated and engaged in their foreign language acquisition and they are able to produce (even in a basic way) sentences and dialogues that link English with a specific and significant content about the natural sciences.

Finally, this research invites both researchers and foreign language teachers to appreciate the benefits of CBI in pedagogical practices. The main contribution of this study was the design of cross-disciplinary lessons based on the natural science curriculum which was introduced into the English syllabus to improve the institutional methodologies and innovative classroom projects.

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Appendix: Sample of a Cross-Disciplinary Lesson

Lesson 1.

Topic. Going to the science museum

Linguistic objectives. By the end of the class the students will be able to: (a) identify the vocabulary about forms of energy, (b) recognize the demonstrative adjectives (this/that/these/those).

Communicative objective. To talk about the elements found in a visit to the science museum.

Warm up. The preservice teacher played short videos about energy, light, sound, and magnetism. Some questions and answers were posed.

Presentation. The girls wrote (in Spanish, with the science teacher's help) some previous knowledge about energy, how we can get it and the objects that produce it. Later, the students and the English preservice teacher started talking about the basic concepts and objects related to energy, light, sound, and magnetism. Then, the preservice teacher introduced some examples and queried the students such as: Does a flashlight produce artificial light? Does the sun produce natural light? After that, she explained the use of the demonstrative adjectives in English.

Practice. Students made drawings and created a word-search puzzle related to forms of energy.

Production. With each of the word-search puzzles, students wrote examples by using the demonstrative adjectives.

Evaluation. The students drew, colored, and classified manmade and natural light on a worksheet. They identified the objects that create attraction with a magnet and the ones that do not. With the help of a guitar, they organized the objects that produce loud and soft sounds. Finally, they created examples by using the vocabulary from the worksheet and the demonstrative adjectives.

As a result, students proved each object found in the classroom by putting a magnet near in order to demonstrate that it creates magnetism. At the end of the class, they said: "It was too easy, teacher." The productions were collected in the students' portfolios.
