A curricular proposal to strengthen scientific competences from academic management

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Summary

This article describes the relevant aspects that allowed the design of a curricular proposal for the strengthening of scientific competence in high school students at San Francisco de Asis School in El Playon, Santander. The proposal includes a pedagogical, evaluative and didactic foundation derived from the analysis of some components of academic management, such as curriculum, classroom practice, improvement plan and pedagogical use of external evaluations.

The research was conducted with a qualitative approach, following the phases of action research. The study was applied to a population of 27 ninth grade students and 8 teachers of San Francisco de Asís School. Two research techniques were used: documentary analysis and semi-structured interview, which allowed for the design of research instruments such as the text assessment rubric and the semi-structured interview guide. These instruments described and explored details of the natural sciences curriculum, "Saber" tests, improvement plans and classroom practices.

The information collected was analyzed and systematized using the Atlas.ti 8.4 program to construct categories and subcategories, codes and network maps. The results were evaluated through the use of a multimethod analysis rubric and the researcher's hermeneutic reading. These results indicate that from components of academic management, it is feasible to characterize a relevant curricular proposal for scientific competence based on theoretical foundations of the curriculum, procedural and formative evaluation, Siemens' connectivist didactics and constructivist pedagogy.

Keywords: Curriculum design, scientific competence, improvement plan, Saber tests, academic management.

Introduction

The main objective of this research was the design of a curricular proposal to strengthen scientific competence from the academic management in a public and rural institution. From this perspective, it began with a process of contextualization of the object of study from the analysis of the results of Saber tests and academic monitoring in terms of the performance of high school students of San Francisco de Asis School. We were able to do a characterization of the environment of the educational establishment and its incidence in these results, the identification of the components and processes that allowed us to establish the research problem, its guiding questions and objectives.

From the fabric of primary theoretical relationships on the notion of competence, curriculum, curriculum design and academic management processes, the description and exploration of the research problem with a coherent constructive logic became evident. The selection and application of a methodology defined for the achievement of the determined objectives, in terms of the methodological design has been characterized by its qualitative nature with an action research approach.

The latter was developed in five phases: a first diagnostic phase and contextualization of the environment, management components, population and sample of students and teachers as participating actors. The second phase consisted of the design, approach and use of techniques and instruments that concatenated documentary analysis and semi-structured interviews for the collection of information. The third phase resided in the analysis of the information from the use of Atlas.ti 8.4 for the survey of categories and subcategories, networks and network maps that helped dimension the conceptual and operational part of the data and its impact on the consolidation of a curricular proposal, providing permanent feedback to the cyclical phase of the action research. For the fourth phase, the information and its analysis were consolidated through the use of triangulation as a strategy for contrasting the data and its meaning, its relationship with the fulfillment of the objectives, strata and categories.

During the design and application of the multimethod or heteromethodological matrix the findings of the resulting information are compared in a correlational way between the common aspects of the strata, techniques and instruments applied and the analysis of the information collected from techniques such as documentary analysis and semi-structured interview following the hermeneutic reading to weave their relationships. The fifth phase of the research process focused on the consolidation of a curricular proposal based on the findings derived from the academic management following the constructive line of techniques, methods, instruments and triangulation. This proposal focused on the weaknesses identified in the aforementioned management component, and its evaluative, didactic and pedagogical processes that underlie the curriculum and curricular design by competences. The corresponding conclusions were made as a closure of the research process for future research to develop reflections on the curriculum for the scientific competence approach.

The changes that have taken place in Colombia have demanded the design of public policies in the field of education, which took shape with the general education law of 1994. In the last twenty-five years, the general education law has redefined the processes of the school and the curriculum, for example, coining terms such as objectives and achievements to describe the school's training areas and their role. It is precisely these conceptual, theoretical and pragmatic changes that have enriched debates about the curriculum, debates led by teachers, researchers and public policy makers who have taken up the new reforms.

A curriculum centered on scientific competence has the duty to eliminate the reductionist vision of the natural sciences and their teaching, as Hodson (1993) states, to give way to the design of pertinent curricula, in accordance with the advances of didactic research, centered on those who learn and to contribute to closing the gap of the school population and its limitations, allowing the great social collective and its individuals to have access to vital scientific and technological knowledge to develop in daily life, the resolution of problems of the context and the awareness of the science-society relationship. Reflecting on the premise that scientific training and competence in this area is as necessary for the citizen as it is for the scientist, as Furio and

Vilches (1997) state when they say that "an ideal of training should be sought where the citizen is not afraid to face the changes that science brings or to diminish their insecurity before scientific reasoning" p.7.

The contributions of the Ministry of National Education (MEN) to the improvement processes have given educational institutions the possibility of building their curricula autonomously and in conjunction with their communities and nearby context, and have also provided improvement strategies that include the approaches of curriculum design focused on competences hand in hand with academic management. According to the MEN (2008) "Academic management is the set of processes that define the curricular components and support pedagogical practice" p.102.

This thesis was developed in San Francisco de Asís School, located in the municipality of Playón, Santander and its main purpose is the design of a curricular proposal for the strengthening of the scientific competence from the academic management. This is proposed in order to encourage scientific knowledge in the young people of the institution from the consolidation of an innovative proposal that combines constructivist pedagogy, a didactic hand in hand with the connectivist theory of Siemens, an approach of evaluation through competences and processes, and finally a curricular design by competences, within which the scientific one stands out.

The validity and feasibility of the research was based on the diagnosis made with the Saber tests of the class of ninth grade of 2016, together with the documents of reflection and self-evaluation in the area of biology provided by San Francisco de Asís School. In the self-assessment document of the biology area, a detail was presented that raises the need to address the strengthening of scientific competence: no ninth-grade student for the year 2019 had top performance, according to the evaluation and assessment scales, as shown in the following table.

Table 1. *Performance of ninth-grade students in the subject of Biology during 2019.*

Number of students in the group:			**27**	**Number of academic periods per year:**				**4**
1	16	11	0	0	59%	41%	0%	0%
2	1	17	9	0	4%	63%	33%	0%
3	8	18	1	0	30%	67%	4%	0%
4	18	9	0	0	67%	33%	0%	0%

Own source and authorship.

As for the results of the Saber tests, these showed that 92% of the students who took the test are in the low and minimum level, that is, they do not surpass the basic elements of the test, denoting a poor level in the performance of scientific competence and its typologies. The table below shows these results.

Figure 1. *Results of performance levels Colfrasis 2016.*

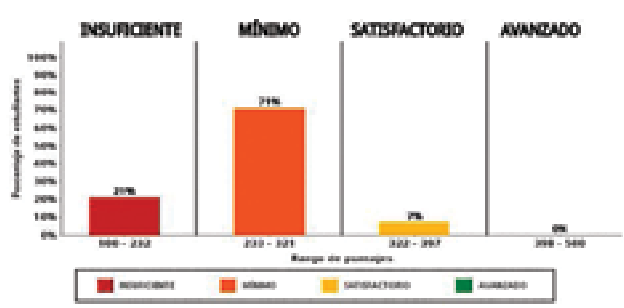

Figure 1. Shows the results by performance levels of the 2016 Saber test in natural sciences, taken from the Saber 3, 5, 9 Test Report. San Francisco de Asís School, MEN (2016). In the realization of this research project, there was great interest in the design of the proposal in order to apply coherent and relevant strategies that were established as a final result of the research process, based on the need to train in

science, and seeking to answer the question: What pedagogical, evaluative and didactic elements should a curricular proposal include for the strengthening of scientific competence, from the academic management, in high school students of San Francisco de Asis School in El Playon, Santander?

In turn, it made it possible to formulate the research objectives and characterize the conceptual elements that guided this process, such as scientific literacy, scientific competence, curriculum and how the development of competences is linked to curriculum design, which were considered to support and weave the theoretical relationships with the methodology used, research techniques and instruments, results and the consolidation of the proposal; for this, the reader is provided with the research objectives and a theoretical approach to the elements that gave rise to this research:

- To characterize the pedagogical, evaluative and didactic elements that should be included in a curricular proposal for the strengthening of scientific competence in high school education.
- To identify the elements of the teaching practice that can strengthen the scientific competence in high school in the San Francisco de Asís School, El Playón.
- To analyze the results of the Saber tests in natural sciences and Avancemos tests in high school at San Francisco de Asís School as a descriptor of the level of performance of scientific competence.
- To qualify the formulation of academic management improvement plans in relation to the strengthening of scientific competence.

One of the first terms that appeared before the notion of applied ***competence*** in education was the model of literacy in different disciplines; natural sciences have not been the exception, when referring to the definition of scientific literacy Bybee (1994) situates ***scientific literacy*** as a research process aimed at reducing the propaedeutic and reduced vision of natural sciences and their disciplines, in order to form learners and citizens who reason scientifically and understand the complex relationship between science and technology, using scientific knowledge to solve contextual problems.

Hodson (1992) considers the process of ***scientific literacy*** as the way in which science is learned and developed at a theoretical and conceptual level, which leads to a problem in the definition of curricula in natural sciences by rethinking the dichotomy between the notion of science for all, to the detriment of the disciplinary training of those who practice science. Other authors, such as Sarabiego and Manzanares (2006), share the definition of scientific literacy in relation to school curricula as one of the most important aspects of scientific literacy:

> The perspectives on the teaching of science centralized in a curriculum that should be modified taking into account the rise of technologies and the very concept of science, besides bringing to the educational arena the debate about the curricular organization of science to train scientists according to contextualized disciplinary knowledge, or failing that, to think about the teaching of science with a guideline of a universal curriculum within the reach of all people (Sarabiego and Manzanares, pp.1-8).

Other authors such as Peña, Pérez & Solbes (2004) consider that scientific literacy and those who design curricula orient the role of science to train students in the rigid language of the disciplines, considering as a priority the foundations, methods and specific principles of these disciplines. In the Colombian context, scientific literacy and scientific education has focused on contributing to the formation of citizens who foster the spirit of research and

the capacity for wonder; the postulates and imaginary of a scientific curriculum should aim to:

> The understanding of natural and social phenomena allowing to place them as subjects in time, in relation to their environment and their own being, to strengthen their ability to raise questions and conjectures leading them to venture in the search for answers and explanations of the observed phenomena and to establish relationships between the information and their findings (MEN, 2004, pp.106-107).

From the diversity of trends and paradigms that offer the possibility of advancing as a society, in this field, the evolution of the concept of scientific competence appears, overcoming the reductionist vision of literacy, retaking the ethical and critical position of the scientific and technological reality, important elements in the development of the central approach of this thesis, for this reason there are appreciations and theoretical approaches to the concept of scientific competence. First a taxative definition of the term competence added to the approach from pedagogy, and then the contribution of the scientific character from various authors in the educational field.

When trying to define the term of ***competence***, Cañas (2014) points out that, despite extrapolating the concept from the world of work, there is a thesaurus of key words that express synonymy when thinking about competence as: capacity, knowledge, skills, abilities, values, attitudes or context, however, he specifies that the ideal definition for competence "is to know how to use at the right time the knowledge and know-how that a competent person possesses" p.31.

The Ministry of National Education (MEN, 2004) defines the term ***competence as*** "the set of skills that an individual has in order to perform a task or work in some area of the economy" pp. 17-18.

The reference of the MEN in terms of competence as knowledge responds to the knowledge, skills and performance required by an individual to perform in a context, the flexible character revolves around the possibility of being able to apply knowledge (including scientific knowledge) to the solution of a problem situation, and context is understood as the environment or place where the acquired knowledge is applied. The MEN proposes the possibility that a competence be assumed from three fundamental pillars: knowing, knowing how to do and knowing how to be:

> A set of knowledge, attitudes, dispositions and skills (cognitive, socio-affective and communicative), which related to each other facilitate the flexible and meaningful performance of an activity in relatively new and challenging contexts. Therefore, competence implies knowing, being and knowing how to do (MEN, 2004, p.18).

Coll & Martín (2006) make an approximation to the concept of competence "as an expression in terms of objectives, contents and their use in different contexts" p. 10, they also contribute the idea that some curricula have not substantially impacted the concept, in more purely descriptive aspects. It is of vital importance for the processes of training and promulgation of skills and abilities in natural sciences, to establish in a clear and precise manner the conceptual guidelines on scientific competence, taking into account the processes, the descriptors and the level of appropriation taking international referents such as the Organization for Economic Cooperation and Development (OECD) or the European Union (EU).

As a result of the reflections made by the OECD, the EU and some international tests such as PISA, the level of meaning of competence is associated with knowing how to use at appropriate times and places the knowledge know-how and know how to live together that characterizes a competent person. In terms of scientific competence from PISA this us allows to:

> Identify aspects related to science, the explanation of scientific phenomena and the use of scientific knowledge and its contents to apply them to contexts that are of interest to the learner. It also seeks to develop attitudes towards scientific research and responsibility for natural resources and health (Cañas, 2014, pp. 34-35).

On the other hand, Hernández (2005), in an accumulation of definitions of scientific competence from its philosophical and epistemic validity, points out that it is the "capacity to recognize the existence and validity of different ways of approaching problems, taking into account their nature and the interests of the research" p.26. Scientific competence will be oriented toward problem solving, a key element in the transition from the formal scholastic and instructional curriculum to the curriculum under the competence-based approach that proposes solutions to the local needs of communities and groups.

Once the epistemological referents related to scientific literacy and its evolution towards scientific competence have been clarified, the impact that these have had on the definition of school curricula underlies. Therefore, and in order to facilitate the reader's understanding, it is necessary to include in this article the theoretical precisions that support the curriculum, curriculum design, types of curricula and the competence-based approach in curriculum design, which, in a not so obvious way, foster scientific learning.

One of the first conceptual difficulties for the clarification of the idea of curriculum, arises from its interaction with the school of today, Correa (2009) determines that the role of this is not neutral, therefore, collects a set of imaginaries and systems that give theoretical support to develop the function for which it was created, undermining the idea that the curriculum must correspond to a theoretical perspective.

Within its evolution and its introduction to the educational field, the concept of curriculum becomes relevant from the conceptions of Bobbit (1924) where he approaches such perception from the etymology of the Latin "curro" or career and its use in the first treatise on pedagogy and curriculum. Subsequently, the conceptions of curriculum evolved during much of the twentieth century, with thinkers such as Saylor and Alexander (1954) focusing the term exclusively on the achievement of school goals and objectives, in turn, responding to the historical line that has been traced intrinsically.

For Glazman and De Ibarrola (1978) the curriculum adopts the delimitation of units or categories of school life in objectives, units and conceptual domains, the appearance of developing the curriculum beyond the curriculum to develop skills, thus denoting a clear diversification of theoretical perspectives that begin to develop, later on, and continuing with the trend of new paradigms. Bernstein and Diaz (1985) define the curriculum as "all publicly accessible educational knowledge" p.3, which in a certain way demonstrates the cultural and explicit character of the concept. There remain some barriers that demonstrate that the curriculum and its construction have been considered outside of a historical process, and that they have been placed there without taking into account the dynamics of the institutions.

The fragmentation of a curriculum as demonstrated by Aristizábal (2005) presents an excessive segregated subject-based approach, without awareness of its history which does not help define what are the purposes and objectives in a clear way for an institution and in general the educational system. By the 1990s, lines of thought converged in order to minimize the fragmentation of the curriculum, such as Torres (as cited in Santome, 1991, p.11), who proposes a curriculum that, in addition to its explicit implications (norms, intentions, and content), brings a new implicit dimension that includes values, knowledge, attitudes, and skills that are taught and learned, defining the hidden curriculum. At the beginning of the XXI century, the concept of curriculum is completely transformed, we find these points of transformation in Iafrancesco, who argues that the curriculum corresponds to:

> The set of anthropological, axiological, formative, scientific, epistemological, methodological, sociological, psycho-pedagogical, didactic, administrative and evaluative principles that inspire the integral information (individual and collective) of the learners in an Institutional Educational Project that responds to the surrounding community and the means for which it is used, such as strategic management, organizational structure, study plans, teaching programs and content, didactic strategies and developments of the processes of formation of the human being in all its dimensions (Iafrancesco, 2004, pp. 26-27). 26-27).

Pursuing the development and purpose of the research, Sacristán (as quoted in Zubiria (2014). p.5) will then come to define curriculum as "the expression to the socialization plan through school practices imposed from outside, which serve as models that teachers have in order to do their work". Then, when reflecting on the role of the teacher, this becomes an important actor for the improvement of the quality of education, the modeling power and the same protagonist for the transformation of their educational practice. The paradigms in educational processes have changed, and made a shift towards an anthropological conception focused on the student body, responding to their needs and interests by reorienting the role of the school towards the pursuit of happiness of the child away from the normative, authoritarian and routine spatial framework of the traditional school (Zubiria, 2013).

Both Iafrancesco (2004), and Zubiria (2013), will come to make contributions on the characteristics that a curriculum should have, from its historical evolution and current trends focused on the language of competences and the interdisciplinary nature of the constructive logic of curriculum design, these contributions set the recognition of the context as a starting point of the curriculum guided by precepts of coherence and relevance, defining the purposes of training in anthropological, axiological, teleological and philosophical areas with


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the help of the educational community. The curriculum should focus on interdisciplinarity from the identification of contextual problems for their solution through the integration of common areas starting from a generating axis, a clear and precise content where the assessment is focused on its formative, procedural and feedback condition.

Methodology

This action research is qualitative. It considered the design of a curricular proposal for the development of scientific competence at the level of high school for a rural public school and tries to address scientific competence in an integral field such as academic management. We hope to provide relevant information for decision-making in PEI (Institutional Educational Process), its processes and reforms. For Hernandez (2018), action research promotes social change of an organization or group, transforming the environment in the short and long term, contributing in turn to the leading role that involves the participants in this process in order to know firsthand the needs to be solved in a context.

According to Álvarez (2003), Action Research (AR) assumes a set of spiral decisions that integrate sequential phases of action for the identification, planning, implementation and evaluation of proposed solutions to contextual problems. For Elliot (1991), action research has the vision of empowering and transforming the objects that are the center of its research process, where it is not only intended to solve problems, but also to generate a profound social change through research.

The study population consisted of 27 ninth grade students of high school level of a public and rural educational institution and 8 teachers. The sampling is non-probabilistic and by convenience, since it allows access to easily accessible sources of information and the availability of the population in a direct way Hernandez (2018). For the data collection process, two research techniques were used: documentary analysis and semi-structured interview. Documentary analysis, together with the design of instruments such as rubrics or text interpretation matrices, make it possible to specify the level of development according to certain criteria and the level of quality of a character, as confirmed by Goodrich (as cited in Yoshina and Harada, 2007, pp. 10-14). As for the documentary analysis, it seeks to:

> Turn to the compression and description of bibliographic sources, as there are contents within the educational research in official documents that help understand the organization, development and evaluation of the educational project. The only observation to consider in the documentary analysis does not necessarily objectively illustrate the educational reality (Hernández, 2016, pp 498-501).

When using rubrics as an instrument for document analysis, Gordillo & Rodríguez (2010) agree in "defining the rubric as a versatile and objective tool that can be used in very different ways to evaluate texts. On the one hand, it provides referent information that provides meaning at the operational level of the concept" p.26.

The second research technique used was consolidated in the semi-structured interview as a possibility to know at the operational and meaning levels to determine what aspects of teaching practice enable the appropriation of science and scientific knowledge; for Hernandez (2018), the interview is "a meeting to converse and exchange information between one person (the interviewee) and another (interviewee or interviewees), where through questions and answers, communication and joint construction of meanings regarding a topic is achieved" p.501.

The use of these research techniques made it possible to define four research instruments: a rubric for evaluating texts from the results of the Saber tests, a rubric for evaluating texts from the academic improvement and management plan, a rubric for evaluating texts from the natural sciences curriculum, and the semi-structured interview protocols. During the data collection process, documents such as the natural sciences area plan were analyzed to obtain information about the curriculum, its meanings and significance in the school life of an institution, along with the development of scientific competence. The analysis of documents and contents of the improvement plan in order to qualify the goals, strategies and instruments that are linked to processes of strengthening scientific competences.

Information was collected from the documentary analysis of the Saber ninth-grade tests as a descriptor of the level of appropriation of the competence it evaluates and in order to identify their weaknesses and strengths at the institutional level. Finally, the application of semi-structured interviews directed to students and teachers described in the target population, allowed the attainment of information of classroom practices and the identification of the evaluative, didactic and pedagogical aspects that help the development of scientific competence.

During the data collection process, the researcher had the possibility of proposing a priori codes or categories, since they can be contrasted in the analysis phase. For their part, Herrera and Guevara (2015) point out that these can be constructed before the collection process according to the proposed objectives. The following table shows the process of collecting the proposed a priori categories and their relationship with the research problem and guiding questions.

Table 2. *Approach to questions and a priori categories.*

Research Problem	Guiding questions	Preliminary categories
What pedagogical, evaluative and didactic elements should be included in a curricular proposal for the strengthening of scientific competence, based on academic management, in high school students of the San Francisco de Asis School in El Playon, Santander?	What are the institutional aspects to be taken into account for the characterization of the natural sciences curriculum at San Francisco de Asís School in El Playón, Santander?	Curriculum
	How could the results of census tests obtained by San Francisco de Asís School be linked as a descriptor of the strengths and weaknesses of scientific competence?	Scientific competence
	How do teachers of natural sciences at San Francisco de Asís School strengthen the scientific competence from their teaching practice?	Teaching practice
	What should the academic management improvement plan include in order to strengthen scientific competence at San Francisco de Asís School in El Playón?	Improvement Plan

Table 2 shows the relationship between the research questions and the survey of a priori categories (own source and authorship).

In order to achieve the proposed objectives, five phases of the research process were carried out: a contextual phase, a design and implementation phase, an analysis and triangulation phase, and an evaluation or construction phase. During the contextualization phase, the population framework, site of action, situations and agents that intervened during the development of the study were structured. The characterization of these elements helped define the problem situation, its relevance, the definition of objectives, methodology, population and sample. The design phase contributed to determine the techniques and instruments of research and its subsequent argumentation for the epistemological and coherent validity within the research logic, determined from the objectives, resources, components and material that are considered for data collection and systematization. The analysis and triangulation phase concentrated efforts on the application of Atlas.ti 8.4 for the processing of the information collected, since, as Hernández (2018) states, the use of Atlas.ti in studies of a qualitative nature allows segmenting data into units of meaning, also, by employing:

> An interview transcript, complete interviews, or the analysis of documents if they were integrated into one, coding emerges in the analysis. It counts and visualizes the relationship the researcher establishes between units, categories, themes, memos, and primary documents. It offers diverse perspectives or views of the researcher's analysis and builds relationship nodes in networks, network maps or categories (Hernandez, 2018, p.451).

The categories that emerged from the analysis were contrasted with Atlas.ti and a multimethod matrix, weaving cause/effect, association or comparison relations between the applied research instruments and techniques. The triangulation of the multimethod matrix, as Cabrera (2005) affirms, obeys to the gathering and crossing the perspectives of the observable realities and their particularities, condensing the information in a pertinent way with the investigated object. The analysis had the constant feedback of the process and the reflections of the study were constructed in punctual and concrete propositions among the common elements found during the data crossing. The multi-method matrix used in the process of hermeneutic triangulation is presented below.

Table 3. *Multimethod Matrix for Hermeneutic Triangulation*

	Categories	Assessment rubric for the natural sciences curriculum and area plan.	Assessment rubric for Saber 2016 Tests	Rubric for evaluation of academic management and improvement plan	Semi-structured interview protocol for teachers and students
Categories		Curriculum	Scientific competence	Academic Management	Teaching practice
Assessment rubric for the natural sciences curriculum and area plan.	Curriculum				
Assessment rubric for Saber 2016 Tests	Scientific competence				
Rubric for evaluation of academic management and improvement plan	Academic Management				
Semi-structured interview protocol for teachers and students	Teaching practice				

Table 3 shows the proposed matrix for the triangulation between applied research methods and techniques (own source and authorship).

In the assessment phase, the processed information was consolidated to characterize the design of the curriculum proposal from the common areas woven with the categories found in relevant aspects for this study, orbiting around the vision of scientific competence from the assessment approach, classroom didactics, the pedagogical use of census assessments, the foundations of the curriculum and pedagogical theory. At the process level, action research was developed in a transversal and heuristic way throughout the study, in order to provide feedback and make adjustments.

Results

From the perspective of the procedure applied and triangulated by Atlas.ti 8.4 and the multimethod triangulation that allowed consolidating the information and contributing to the achievement of the central purpose of the research work, four categories and five subcategories were identified when contrasting the relationship between techniques, instruments and strata. Table 4 below presents a summary of the resulting categories.

Table 4. *Categories and subcategories resulting from the triangulation process.*

Technique	Instrument	Category	Subcategories
Documentary analysis	Matrix of assessment of written texts.	Curriculum	Curriculum coherence Classroom pedagogy Assessment of learning Appropriateness of area
Qualitative analysis of test results	Matrix of evaluation of ninth-grade Saber tests.	Scientific competence	Explanation of phenomena Inquiry of phenomena Use of scientific knowledge
Documentary analysis	Improvement plan text assessment matrix	Improvement Plan	Curriculum Classroom teaching Methodological approach Pedagogical style Evaluation of learning Study plan Use of external evaluations
Semi-structured interview	Semi-structured interview with teachers and students.	Teaching practice	Attitude towards science Learning environments Learning styles Learning assessment Curriculum planning Pedagogical use of external tests

Table 4 shows the relationship between the categories and subcategories resulting from the application of Atlas.ti 8.4. and the multimethod matrix (own source and authorship).

The first resulting category is related to the ***curriculum,*** understood as the set of methodologies, study plans, didactics, strategies and evaluation approaches that guide the pedagogical work of an educational institution and orient its institutional educational project. When comparing this category in relation to the analysis of the area plan and curriculum of natural sciences, together with the other categories found, it was determined that the pedagogical theory and model identified in the contextualization phase is constructivist with a humanistic approach; however, in its curricular structure it ignores the postulates of reference theorists such as Piaget, Ausubel or Vygotsky.

The structuring of the curriculum focuses on content and teachability processes using terms such as objectives and achievement indicators, ignoring the characterization of a curriculum based on a competence-based approach. The curriculum category does not involve the logic of conceptual areas for the development of scientific competence, and underlies the world view of a memoristic and mechanistic assessment.

The second category involves ***scientific competence***, beyond the development of science skills, a category that emerges from the analysis and qualitative interpretation of the results of external tests such as Saber 9. The scientific competence showed a weak, partial and low development in 25 students out of 27 who took the base test for the analysis, and it showed the deficiencies in scientific competences of the educational institution that is the object of this study in terms of types of competences such as the use of scientific knowledge and inquiry of phenomena. It describes the deficiencies of competences in terms of thought processes and skills such as:

- Evaluating predictions of phenomena from research.
- Analysis of information and handling of science concepts.
- Evaluating observations by recognizing data patterns.
- Explaining phenomena based on data and graphs.
- Association of natural phenomena with science concepts.
- Prediction of phenomena following regularity patterns.

On the level of appropriation of scientific competence in the educational establishment, its results placed it below other similar establishments at the urban or rural level with the same socio-economic index.

The third category brings together the elements of the ***improvement plan*** focused on scientific competence and the route taken by the institution for its improvement. The improvement plan constitutes the self-evaluation process to reflect on the management components and processes that have been developed in the institution. From the improvement plan and in general from the academic management it was determined that, regarding the formulation and improvement goals, the scientific competence was not considered as a priority character taking into account quality referents such as external tests. The improvement goals were formulated in the short term and placed in chronogram, objectives and people in charge, however, it did not take into account clear and precise instruments for the follow-up of the improvement plan.

The fourth category called ***teaching practice*** brings together the design, search, selection, application and contextualization of didactic resources, evaluation approaches, pedagogical theory and curricular execution

necessary for the construction of a curricular proposal for scientific competence and the area of natural sciences. Teaching practice evidenced a theoretical gap between the macro and meso-curriculum of the institutional educational project and the one is developed in the classroom; teachers develop their practice according to the structured curricular models and grids.

The didactic strategy is specific to each specialist teacher in his or her disciplinary field, tending to the development of content and teaching. For the mediation of scientific knowledge, no solid guiding threads are developed that meet the criteria of relevance, transversality, sequentiality and complexity necessary for learning.

In the indicators and results of the interview applied to the students, we inquired about their perceptions on the evaluation and didactics used by teachers. A significant sample of students recognized the need to use web 2.0 tools for the process of mediation of their learning and in turn, denoted the importance of including curricular aspects in the area of science such as laboratories or technological resources. They stated that other modes of evaluation should be instilled beyond the written and workshops, and demanded participation in the processes of self-evaluation of the educational establishment.

On the other hand, teachers indicated that they did not know part of the classroom strategy defined by the institution, some assessment criteria applied to learning and the limitation in training aspects in order to develop a curriculum in a cross-cutting manner for basic competences such as science; they stated that, despite every year modifications are made to the curricular frameworks based on self-assessment processes and Saber tests, these are not socialized and they guide their practice with available texts such as primers or Santillana books.

In general terms, students and teachers expressed the need to articulate the scientific competence in a way coherent to the theoretical formulation of the curriculum described in the Institutional Educational Project in terms of a classroom practice with a constructivist approach, a procedural and formative evaluation, a didactic that uses web 2.0 tools for mediation processes between teaching and learning, finally the need to rethink and resignify the curricular structure that concatenates the aspects described above.

Construction of the proposal: Concientic 1.0

The construction of the curricular proposal for the strengthening of scientific competence started with the findings of the triangulation and data processing with Atlas.ti; it was consolidated under the name of Concientic 1.0. The sum of the characteristics of a curriculum of natural sciences agglomerates a didactic conjugated with a pedagogical theory that helps understand the experiences, environments and relationships in the classroom expressed through classroom practice in favor of the development of scientific competence.

Finally, the evaluation component has repercussions from the formative, procedural and results options, in the conjugation of the theoretical options for the development of a natural sciences curriculum, derived from the research line and process developed so far. The scope of the Concientic 1.0 proposal, its contribution to the research problem addressed and its applications are available at https://pedrazayeison3.wixsite.com/aulavirtualcolfrasis.

The construction of Concientic 1.0 revolved around the resignification of the constructivist pedagogical theory from the Institutional Educational Project and its theoretical support. At a theoretical level, the constructivist referents of the proposal provide relevant circumstances and ideas, which, as Granja (2015) states, go beyond the elementary definition of constructivism beyond the fact that each learner constructs his or her own knowledge, by establishing this approach as a product of the interaction between teacher and student.

The perspective of Piaget, Ausubel and Vygotsky was retaken, each of them with important conceptual elements, for example, Granja (2015) confirms that, within constructivism, Piaget's theory, enables the development of vital thought processes according to biological and cognitive age, which aim to address thought processes from the modification of cognitive structures, vital, for example, for the development of scientific thinking with skills such as: acquiring, elaborating, organizing and using information, which make it possible to face the demands of the environment, solve problems and make appropriate decisions.

Granja (2015) points out that, from Ausubel's point of view, the appreciation and weighting of pre-knowledge is valued. Ausubel stresses the importance of combining thought processes hand in hand with the mediation of the teacher, both logical and affective thinking, which favor the training process, and, in a coherent manner, it is articulated to scientific competence. From Vygotsky's contributions, the author delimits the possibility of constituting learning, according to the influence of the environment, from the perspective of the subject and its social possibilities, for example, if it is related to the critical character of science, this should play a role in the solution of social and health problems, from the knowledge of the subject and the experience that he acquires as a member of a group.

From the curricular component of Concientic 1.0, the performances and contents were defined by levels that show their complexity and interrelation according to the grade of schooling of the subject, therefore, their sequencing in a logical way from the horizontal and vertical reading of the curricular integration.

Concientic 1.0 assumes the curricular design from the vision of process, and not from the gradual vision of the traditional school, so the whole level of high school education is taken into account as a process.

The existence of four guiding threads that function as the axis of articulation and cohesion of the competences to be developed was proposed taking into account the grades that make up high school. As suggested by Zubiria (2014), the threads imply the sequencing of an organized curricular mesh and, above all, that allows the development of a thinking process:

> A good curricular and didactic organization is, above all, inter-structural, since both the teacher and the students play leading, differentiated and complementary roles. Neither the teacher authoritatively imposes knowledge - he cannot do so, because students have minds - nor the students impose their passing whims on the course p.16.

The didactic component of Concientic retakes the irruption of Web 2.0 tools and connectivism, as an option according to the described pedagogical and curricular route; connectivism expresses the connections that can be established between the construction of learning and the use of web 2.0 tools, in its character of mediation. Siemens (2017), describes that connectivism allows the learner to grasp and establish relationships between the activities focused on learning and its formative intentionality, that is, it allows the learner to build what he/she wants to know (constructivism), while Morrás (2014) states that "connectivism can be considered as a theory of learning; in any case it would constitute a pedagogical proposal in line with the new realities derived from the web 2.0" p.40.

The evaluation component of Concientic 1.0 integrates the use of a qualitative, procedural and formative evaluation based on the use of rubrics to assess learners, coherently attenuating the other components of Concientic 1.0. The guiding principles of the assessment component, according to Castillo (2006), underlie the principle of rationality, understanding assessment as a process aimed at learning and how to take advantage of the information gathered. The principle of responsibility responds to the areas of commitment and training, where the aim is to improve the quality of processes, which allows for the development of scientific competences.

The principle of collegiality focuses on determining the assessment process in precise levels of thought, progressive and sequenced in order to make decisions for intervention in the grades and levels of schooling. The principle of perfectibility seeks to ensure that assessment processes and, in general, educational processes, improve constantly according to their needs and context. Finally, one of the important principles is that of coherence, that is, in the perspective of Rosales (as cited in Granja, 2015, p.106) the evaluation is assumed as a tool for collecting information about the components and teaching activities, interpreting this information and making decisions that improve the educational process.

Conclusions

The construction of a curricular proposal for the strengthening of the scientific competence in students of high school of a public and rural institution, assumed from processes of academic management, represents the pedagogical, didactic and evaluative consolidation properly plotted in the research process which overcomes the imaginaries of the traditional proposals in education and science in the school. It consolidated, hand in hand with educational actors (teachers, students and parents) successful experiences on the role of the curriculum in school environments and training in scientific competences in the area of natural sciences.

In this way, from the concretion of the proposal, it was possible to re-define a curriculum for the formation of scientific competences, from the contextual needs and permanent efforts of its actors for a good education; it determined the options of pertinent and contextualized formation, the structuring of the scientific competence in the spaces of the pedagogical practice, the inclusion of the different learning styles, the reflection of the pedagogical action and the cultural factors that forge the identity of the school.

From the design and construction of Concientic 1.0, a methodological route became effective for the initiation of improvement processes that have an impact on curriculum design and the characterization of the focus and language of competences. In this way, modifications were made to the natural sciences area plan, articulating public policy documents such as basic competence standards, basic learning rights and reference matrices, in addition to guiding threads and performance indicators that account for knowledge, know-how and knowing how to live together.

Concientic 1.0 functions as a space where the reflections that teachers and students can make in their interactions hand in hand with pedagogical praxis make explicit the relationships and organization of the curriculum as well as the role and pedagogical use of the results of external tests as quality references, to determine a starting point between the strengths and weaknesses of an educational establishment in terms of competences, to formulate strategies that converge in changes in the curriculum and to identify the impact of a competence in terms of thinking skills.

It confirms that the formulation of the improvement plan concatenates the self-evaluation of the academic process of an institution and its efforts by considering the participation of the members of the educational community, the weaknesses of the teaching practice, the visions of the evaluation applied to the classroom in a consensual manner and establishing short and medium term objectives without leaving aside the constant reflections of the study plans and the curricular organization, by understanding the teaching-learning process as a dynamic system that must be permanently updated, especially with a leadership of the teachers and students of a community.

Concientic 1.0 establishes a common framework where the pedagogical foundation and learning theories that support a curriculum respond in a coherent and well-structured logical line, between the curriculum (Institutional Educational Project) and the one that is executed in the classroom, avoiding the conceptual and practical gap between the two, through the use of a sequenced, complex and spiral curriculum, articulating the assessment approach in a procedural and formative way, considering the development of a sequenced and complex learning beyond the punitive, summative and quantitative aspects of the assessment approaches.

The didactics used in the classroom by teachers must ensure that they promote scientific learning that is meaningful to their students which contribute to solving problems of the context, health and the environment. One of the attributes that can supply the interest of students towards science can revolve around the application of teaching strategies based on problem solving or the use of strategies and tools of web 2.0 coupled with digital education models, such as connectivism which contributes to a coherent development of constructivism and its implications in the classroom.

In terms of difficulties, the present study had to overcome the vicissitudes of the health emergency resulting from Covid-19 and transfer part of its methodological route to virtuality and remote education with technological mediation, and, on the other hand, to estimate the future impact that Concientic 1.0 may have on the level of appropriation of scientific competence. However, the research work consolidated the use of techniques and instruments to apply to future research that pursue the curricular line and the development of competences in natural sciences from the particularities of each context, which allow their students to develop skills that -today and in situations of public adversity- solve problems at local, regional or national level.

Recommendations

For the present research, a curricular proposal was constructed that included an evaluation coherent with constructivism and its pedagogical foundation using evaluation rubrics that propose performance levels and their attributes. We recommend the use of a didactic that articulates the constructivist methodology and connectivist pedagogical theory hand in hand with web 2.0 tools, a curricular organization in sequence and complex spiral focused on thought processes involving the typology of scientific competence. However, there are still some recommendations and improvements that can be made in the future.

We should estimate the impact of the proposal over a period of three years in order to identify strengths and weaknesses that will help improve the application of the virtual learning environment "Concientic 1.0", as well as provide feedback to these spaces based on the results of future external tests that measure scientific competence for pedagogical and curricular decision making.

For future in types of research that have as an object the curriculum and improvement of competences, we should use research techniques such as non-participant observation to contrast in an effective way, the theory of the institutional educational project with the educational reality that appears in the teaching practice, since in the present research, this could not be applied due to the mandatory confinement and the cancellation of face-to-face classes due to Covid -19, which would have enriched the sources of data collection and analysis of the information.

There is the possibility that from different areas educational institutions decide to employ improvement strategies, therefore, this research and its results can function as guidelines for the design of teaching models that are based on constructivism and coherently develop the educational process, linking academic management and reorienting the role of curriculum.

There are elements that were not considered in the proposal of the curricular proposal: multimodal factors that, as defined by Izquierdo (2007), have an impact on the constant improvement and innovation of science in the classroom: the emotions of the learners. These can be determined through the transversality of citizenship competences and this area can give rise to new lines of research. The emotionality of a learner helps science to advance when the scientific spirit and the capacity to be amazed by each new event, by each scientific phenomenon that is not yet known, is raised. Science education is not only for scientists, it is also about training and preparing citizens for future environmental, social and public health challenges.

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