literatura actualmente disponible en la red de bibliotecas. Es muy alto el por ciento de computadoras que no pueden ser utilizas por problemas de rotura, sin que se haya logrado una ágil reparación por parte de las entidades encargadas de ello…" (Informe, 2012)

Hoy día se estudian otros cambios aun en estudio que implicaran nuevas formas de ingreso, reducción del tiempo de duración de las carreras, etc., a fin de adecuar el modelo educacional cubano a las tendencias del mundo actual y a las condiciones actuales del país lo que pudiera constituirse en un futuro no muy lejano como la 4ta. Revolución de la Educación Superior Cubana.

Finalmente pudiera expresarse de forma resumida algunas conclusiones que pueden caracterizar a la Educación Superior en Cuba:

La formación de profesionales en Cuba hoy día está caracterizada por:

- formar un graduado de perfil ancho donde se ponen de manifiesto dos ideas rectoras:
- La unidad entre la instrucción y la educación
- El vínculo entre el estudio y el trabajo
- ser científica, tecnológica y humanista.
- cubrir las necesidades de superación de los profesionales del país.
- aplicar las innovaciones tecnológicas y educativas al proceso docente
- tener una plena integración con la sociedad.
- estar presente en todo el país.

Se cumple así la frase del apóstol de Cuba José Martí "El pueblo mas feliz es el que tenga mejor educados a sus hijos, en la instrucción del pensamiento y en la dirección de los sentimientos". "Un pueblo instruido será siempre fuerte y libre" (Martí J, 1961)

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Received 20-07-2015 /Approved 30-11-2016

Environmental education in school chemistry textbooks in Brazil
Educación ambiental en los libros didácticos de química en Brasil

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Abstract

At present, Environmental Education is a daily topic in schools. Additionally, it is noted that the textbook is a very significant instrument, since it is used as the main didactic resource in the teaching-learning process. For that reason, the purpose of this research, of a qualitative nature, is to describe and analyze the ways of presenting the environmental theme in the didactic Chemistry books recommended by the Textbook Guide for the Brazilian National Textbook Program (Programa Nacional do Livro Didático Brasileiro - PNLD) 2015 for intermediate education. For such, a documentary analysis of the books was carried out, to see if an expressive presence of the Environmental Education theme is observed in the works examined. Thus, it can be verified that the analyzed books feature reading, research and reflection activities relating to the issues being studied. Such a fact provides evidence of the potential that such books feature to support the awareness and building of citizens where environmental issues are concerned.

Key Words: *environmental education, textbook, science teaching, chemistry teaching*

Resumen

En la actualidad, la educación ambiental es un tema cotidiano en las escuelas. Además, se observa que el libro didáctico es un instrumento muy importante, ya que se utiliza como principal recurso didáctico en el proceso de enseñanza-aprendizaje. Por esta razón, el propósito de esta investigación, de carácter cualitativo, es describir y analizar las formas de presentación de temáticas relacionadas con la educación ambiental en los libros didácticos de química recomendados por la Guía del Libro Didáctico en el Programa Nacional del Libro Didáctico de Brasil (Programa Nacional do Livro Didático Brasileiro - PNLD) 2015 para la educación secundaria/bachillerato. Por ejemplo, se realizó un análisis documental de los libros, donde se observa una presencia expresiva de la temática de Educación Ambiental en las obras examinadas. Además, se pudo verificar que los libros analizados cuentan con actividades de lectura, investigación y reflexión sobre los temas que han sido evaluados. Tal hecho destaca el potencial de emplear esta temática como herramienta para sensibilizar a los ciudadanos sobre diferentes cuestiones ambientales.

Palabras clave: *educación ambiental, libro didáctico, enseñanza de las ciencias, enseñanza de la química*

INTRODUCTION

School education occurs through the didactic-pedagogic mediation that is established between practical and theoretical knowledge. Thus, its procedures require adjustments not only to the particular situation of the school and the development of the learner, but also to the several areas of expertise that are needed. This brings out the importance of the Textbook (TB) as the reflection support for that particular situation, with attention to the double requirement: on one hand, the procedures, information and concepts suggested by the school books; on the other, the actions,

information and concepts that need adjustment to the didactic-pedagogic situation they are aimed at.

The National Education Law of Directives and Foundations in Brazil (*Lei de Diretrizes e Bases* - LDB), Law Nr. 9394/96, quotes the pedagogic material support programs in its Article 4th, Line VII: "The duty of the State regarding public school education shall be made effective by means of assuring attendance of students in Elementary Education through supplementary didactic material programs [...]" (Brasil, 1996).

It was Decree Nr. 9154/85 that regulated the TB in Brazil that instituted the Textbook National Program (PNLD). Currently, Resolution Nr. 03 of the Deliberative Council (DC) of the National Fund for Education Development (*Fundo Nacional de Desenvolvimento da Educação* - FNDE) from February 21, 2001, has become the organizing and regulating engine for the PNLD (Brasil, 2001). The Ministry of Education (*Ministério da Educação* - MEC) in Brazil created several commissions to evaluate the TB in pursuit of better quality.

The TB is a pertinent tool to provide students with access to technical-formal knowledge. Furthermore, it is known that for many families, the TB is the first book they have in their homes. This way, it is the piece of work that may open the path to a reading habit and learning. Lopes (2007) designated a classic TB definition, of "being a didactized form of knowledge for schooling purposes and/or aimed at forming values" that configure conceptions of knowledge, values, identities and vision of the world.

At the official level, restlessness with school books in Brazil begins with the TB legislation created in 1938 by Decree-Law 1006 (Romanatto, 2000). During that period, a book was deemed a political and ideological education resource, with the State being the censor for the use of the didactic material. The teachers would choose books in view of a pre-established list at the foundation of that legal regulation, Article 208, Line VII of the Federal Constitution of Brazil, where it is defined that the TB and the Portuguese Language Dictionary are a Brazilian learner's constitutional right (Núñes et al, 2003).

Since printing of the first TB began in Brazil, they have undergone several changes aimed at following new classroom trends and more meaningful learning. Furthermore, the TB is an important teacher work assistance resource and a reference in the development of millions of children enrolled in public and private schools. Brazil has one of the most advanced programs for the free distribution of thousands of school books to the public teaching network, and in order to obtain a quality result in the elaboration of those didactic-works, the printing industry needs to assimilate the particularities and requirements of the school routine in the TB elaboration process, encompassing the work of a multidisciplinary team of qualified professionals with classroom experience.

To be suitably used by learners, the TBs must comprise tools that raise a discussion about the theoretical content with the purpose of allowing for its structuring into knowledge (Vasconcelos & Souto, 2003), having students take over the knowledge and with it be capable of making their own decisions as critical, thinking beings.

This way, the appropriation of scientific knowledge brings about the choice of a methodological approach that is coherent with the conception of teaching (Peruzzi et al, 2000) that carries the intent to instigate and develop several cognitive competences such as comprehension, investigation, analysis, hypothesis formulation, and planning. In fact, the TB may not privilege any of those competences in favor of the others (Brasil, 1997a)

For many Brazilian public schools, the TB is very often the only source of classroom work as printed material, and so it takes on the role of a fundamental tool for the learning of students in such teaching institutions. This way, the choice of school books must be well analyzed by the teacher so that such resource brings the opportunity for learners to have activities that would lead them to develop different competences.

According to contributions by Santos & Carneiro (2006), the TB features three main functions in the learning-teaching process: (a) information, (b) structuring and organizing learning, and (c) acting as the student's guide in the outside world apprehension process. In this sense, the book may be extended as a tool that would allow for greater interaction of students' experiences and knowledge with the theories and new knowledge through the mediation of teachers with the use of the activities proposed by that didactic resource.

The TB is also recognized as being a significant learning process tool in European countries such as Germany, Poland and Finland, as well as in Asian countries such as Singapore and South Korea (Oates, 2014). Martin et al. (2012) point out that, when associated with factors such as broad investments in teacher formation and the historic valuing of the profession, the use of the TB in the classroom may have contributed favorably to the considerable school performance attained by students from those countries. The authors highlight that 94 percent of teachers in Finland and 68 percent in Singapore used TB in their Science classes.

Oates (2010) stresses that the TBs adopted by each nation are directly related to the national curricula elaborated by their managers. Additionally, those texts are products of a national cultural, economic and political link network that represent and incorporate the culture and knowledge deemed necessary by those in power. Thus, the textbooks include an ideological dimension. In a study carried out with 200 books in England, Oates (2010) identified that the TB can be classified as being Traditional, Specific Models and Instrumental. The Traditional ones are usually simple and present a specific subject content, with the advantage of not placing emphasis on a single teaching model to present or structure the contents. The Specific Models explicitly favor one teaching method, for example, a revision activity, introduction to contents, research activities or exercises. In the third category there are the Instrumental books, which are strongly related to exams as they are elaborated with the purpose of exam and evaluation preparation and to not allow for diversification of methodologies.

According to Oates (2014), the non-use of good quality TB may have contributed for the lower performance of English students compared to the previously mentioned Asian and European students. Within that scope, the author points out the need to encourage more English schools to adopt well structured textbooks:

> This provides significant impetus to self-searching criticism of the status-quo in England, and to concerted effort by publishers, the State, researchers and educationalists in order to align more with emerging international standards of excellence – both in the form of textbooks and the patterns of their use. (Oates, 2014, p. 20)

In the USA, scholars assure that good textbooks encode and synthesize knowledge in a suitable form for cognitive, affective and social nurturing of students (Tucker, 2014).

For Tucker (2014), textbooks should not be seen as a complete study program or course. but be created as a vehicle for investigation, together with the use of a range of printed materials and other means of communication. The author further explains that if the school book is designed to fulfill the function of general education, exploratory teaching, education enrichment, or even specialized education, in order to succeed well it must be a generator of ideas, concepts and skills for significant application in the students' lives and growth. The scholar stresses the role of teachers by pointing out that the best textbooks depend on teachers for their successful use in the teaching-learning process.

It is a known fact that no matter how good the choices regarding school books, they have their limitations. Thus, it is up to the teacher to overcome those restrictions that are inherent to those works, which due to their generic character, are not able to contextualize all knowledge, likewise, can not contain specific activities to meet local issues. It is the task of the faculty to complement, adapt and provide more meaning to the contents worked in the books recommended in Brazil by MEC (Núñes et al, 2009).

In this sense, the Portuguese Language National Curricular Parameters (*Parâmetros Curriculares Nacionais* - PCN) for Elementary Education (Brasil, 1997b) make teachers ponder on the TB pedagogical usefulness. Examples of reflections are: Are the concepts correct? Are they adequate? Do the exercises help students think and develop critical reasoning? Do the illustrations contribute to text comprehension?

This way, the answers to those and other questions shall guide the choice of a book that would aid the teacher's pedagogical activity. However, it must be pointed out that the TB is only an instrument of support for the teachers' work and that no matter how complete it may be, it requires complementary activities that favor the discussion between students and teachers that consider the different local/regional realities, to then contribute towards effective learning by the students.

This way, it can be perceived that the choice of a certain school book and its use in the classroom is a very difficult topic, since it must consider the definition of criteria that make the choice process operational and promote a discussion about the learning-teaching process.

According to an historic study by Maia et al. (2011), the TB arrived at schools in 1929 through the National Book Institute (*Instituto Nacional do Livro* - INL), whose function was to evaluate and select those books. In 1966, an agreement was signed between MEC in Brasil and the U.S. Agency for International Development (USAID) with the purpose of

distributing free books during three years to students. USAID would have control over the production, publishing, illustration and distribution of the books, and MEC would be in charge of the execution. In1971, the agreement was cancelled and the INL took over management of matters related to the TB and created the Textbook Program for Elementary Education (*Programa do Livro Didático para o Ensino Fundamental* - PLIDEF). From 1985, the PLIDEF was replaced with the current PNLD centering on the free distribution of books for elementary education and child literacy classes.

In 2004, the Brazilian government also created the National Textbook Program for Intermediate Education (*Programa Nacional do Livro Didático para o Ensino Médio* - PNLEM), by which it makes the TB universal for students from intermediate education in the whole country. Upon evaluating the works, MEC publishes the Textbook Guide with summaries of the collections that are considered as approved. From then, this Guide and the books are sent to the schools that choose two options of works for each year and subject among the titles available, according to the propositions that best suit their Pedagogical Policy Project (Maia et al., 2011). If the purchase of the first choice is not possible, the second choice is sent to the school. Therefore, the choice of the second option must be as strict as of the first one.

Every year, MEC acquires and distributes the books to students in public schools in alternate, three-yearly cycles: early years to the elementary education, late years to elementary or intermediate education. Students should return the books after using them for one year, as they will be reused during the following years.

Where the both the conceptual and methodological environmental issue is concerned, the PNLD 2015 is assessing whether the works for the Chemistry curricular component cover the environmental dimension of contemporary problems, the human processes, situations, concepts and technological artifacts that involve the transformation of matter and the production forms in the world of the work (*Guia do Livro Didático*, 2014).

Those criteria converge with the determinations from the current National Curricular Directives for Elementary Education (Brasil, 2012), Resolution Nr. 02 from 30 January 2012, by the Basic Education Chamber (*Câmara de Educação Básica* - CNE) of the National Education Council (*Conselho Nacional de Educação* - CNE) from the Ministry of Education (*Ministério da Educação* - MEC). Those directives define that the environmental topic must be developed across the whole curriculum aimed at an integrated educational practice that develops conceptual, procedural and behavioral aspects directed towards the respect for and preservation of the environment (Brasil, 2012).

This way, Environmental Education arises as a set of educational practices seeking to insert a new ecological awareness in all the subjects of the school curriculum. The Environmental Education practices should not simply convey knowledge of the environment, but also promote a shift in behaviors and attitudes, a determination to take action and the pursuit of solutions for the environmental issues (Cassiano & Echeverría, 2014) This is the point where Environmental Education allows for a critical and conscientious formation of citizens, in the light that they are part of the environment.

In the face of such reality, the TB plays a highly important role in formal environmental education, as it is an element that is present in the classroom and aids the implementation of the education policies in general. The TB appears as an ally for working in a cross-curricular fashion using interdisciplinary themes, such as the environmental issue (Marpica & Logarezzi, 2010).

In that sense, Corrêa et al. (2013), believe the TB corresponds to an important instrument of mediation between formal and scientific knowledge and the empirical and informal knowledge of teachers and students, founding, this way, the intellectual development of the subjects implied in the teaching-learning process.

Within this context, the present investigation is one of the stages from a case study aimed at assessing the presence of environmental education related themes in the PNLD 2015 textbooks. Thus, the objective of this work is to analyze the organization of the book volumes, identify the themes worked on about Environmental Education and the methodological resources. This way justifies the analysis of how the Environmental Education theme is represented in the TB as it helps to think critically about one of the most widely used pedagogical instruments in the classroom. Furthermore, it is an exercise aimed at reflecting upon the potential of cooperation by these works to build knowledge related to such a pertinent focus.

METHODOLOGY

This research is of a qualitative nature. Qualitative research, according to Denzin & Lincoln (2005), involves a naturalistic, interpretative approach of the world, which means that researchers study phenomena in their natural settings, attempting to understand or interpret those phenomena in terms of the significance people place on them.

For such, the investigation was performed from a Documentary Analysis (Lüdke & André, 1986). Documentary Analysis is a technique that makes the qualitative investigation feasible by considering any written material about human behavior as a resource that can be used for the study. Moreover, the documents may be associated to other data gathering technique, such as questionnaires, interviews and observations.

Still according to Lüdke & André (1986), documents may be classified into official (legislation, decrees), technical (reports, projects, books) and personal (letters, diaries, autobiographies). Thus, the documents analyzed during this work were the following: textbooks (technical documents) and the Education Legislation (official documents).

Reading and analysis of the documents were carried out under the Content Analysis strategy that is characterized as one of the classic procedures to interpret text materials. According to Bardin (1977), Content Analysis helps the researcher highlight ideas, statements and propositions (qualitative or otherwise) in the text that may have isolated meanings. Following that, the meaning cores are determined, that comprise the communication and whose presence, or appearance frequency, may be significant for the chosen objective.

The analyses of the Chemistry TB considered the presence, frequency and similarity of the Environmental Education related themes presented in the tables of contents, texts, activities and illustrations of books. Towards that sense, six analysis categories were elaborated: (i) *Pesticides of Fertilizers; (ii) Water and water pollution; (iii) Energy (petroleum, biofuels); (iv) Industry and residues; (v) Sustainability and waste; (vi) Atmospheric pollution (global warming, greenhouse effect and acid rain)*. Those categories will be presented and discussed further on in this paper.

RESULTS AND DISCUSSION

Based on the methodological presumptions described above, we analyzed three volumes from the four Intermediate Education Chemistry textbooks offered by the PNLD 2015 Textbook guide (Table 1) for the Environmental theme approach.

Table 1. List of TB analyzed – all works have three volumes.

Book	Authors	Book Title	Publisher/ City	Year
A	PEQUIS Wildson Luiz Pereira dos Santos & Gerson de Souza Mól	*Química Cidadã*	AJS São Paulo – SP	2013
B	Murilo Tissoni Antunes	*Ser Protagonista - Química*	SM São Paulo – SP	2014
C	Martha Reis	*Química*	Ática São Paulo	2014
D	Eduardo Fleury Mortimer & Andréa Horta Machado	*Química*	Scipione São Paulo	2014

All books that were analyzed are divided into three volumes. Each volume is divided into "units", which are subdivided into "chapters". As Table 2 shows, it was found that Environmental Education features in all 12 volumes analyzed, and in all 12 volumes analyzed, following the trend pointed out by Cassiano & Echeverría (2014), when they analyzed PNLEM Chemistry books in 2008. Internationally, environmental thematic are present in Science TB in relation to either the scientific contents (Occelli e Valeira, 2013) or the theoretical knowledge required to study the thematic mentioned (Blum, 2008; Karatekin, 2012). Some studies highlight that the conceptual environmental knowledge is included in the TB, but the procedural and attitudinal knowledge necessary for environmental literacy and the conservation of the environment are not included in the proposed texts and activities in the TB (Blum, 2008; Karartekin, 2012).

In the PNLD 2015 books, the themes: "Water" and "Energy" are the most widely worked on and recurrent in more than one of volume from each Book, except for Book A. It can be observed that Book A covered the

themes in a comprehensive manner in only one volume, as opposed to the others that featured the discussion in more than one part of the chapter or in different chapters in each volume.

Table 2. Themes found in the respective TB regarding Environmental Education.

Theme/ Category	Book A			Book B			Book C			Book D		
	v.1	v.2	v.3	v.1	v.2	v.3	v.1	v.2	v.3	v.1	v.2	v.3
Agrochemicals or Fertilizers	X				X	X		X	X		X	
Water and water pollution		X		X	X	X	X	X		X	X	X
Energy (petroleum, biofuels)		X		X	X	X		X	X	X	X	X
Industry and residues			X		X	X	X	X	X	X	X	
Sustainability and Waste	X				X		X	X	X	X	X	X
Atmospheric pollution (global warming, greenhouse effect and acid rain)	X			X	X	X	X		X		X	X

The Book A Units featured a cover showing one or more images related to the theme to be worked on. In the Unit's cover, there is the table of contents and subjects covered in each chapter. Chapters are introduced through a broad text (one, two or three pages) with the title "Focus Theme" presenting a social theme to contextualize the chemical knowledge. Through the development of the chapters, there is "Debate and understand", which is a reflection exercise for a debate. The topic "Think About It", during the text provides a reflection exercise for students. Whenever the heading "Science and History" appears, there is a text with a historic relation about the appearance of definitions and concepts of the contents being studied. In "Action and citizenship", the authors propose activities for the students to get to learn about their communities. The topic "Chemistry in School" carries proposals for investigative experiments, many of which may be done in the classroom. In "Sustainable Attitude", suggestions are offered, as well as precautions for practicing citizenship, especially where environmental impacts are concerned. Also part of the Book A structure are the "Exercises and Activities" to review what was learned in the chapter and still at the end of the chapter "What we have learned in this chapter" that presents a summary of the chapter.

In Book B, the Unit opening page shows an image and a small, half page text relative to the theme of the Unit. In the opening of the chapter, the authors once more present an image and a text. The text relates the context of the image with the chapter subject. In the presentation of the contents, the authors show thematic charts in "Learn more", where the content is shown more in depth or some concept covered in the Book is revisited. In "Activities", the authors offer exercises about themes studied in and questions from the National Intermediate Education Exam (*Exame Nacional do Ensino Médio* - ENEM) and from university entrance exams. At the end of the chapters the topic "Science, technology and society" is presented in which the authors work with complementary illustrated texts followed by questions for reflecting on subjects covered during the chapters. The book further presents proposals for experimental activities in "Experimental activity", suggesting two projects to get the community involved in "Projects" and also texts or activities that relate Chemistry with the other areas of knowledge in "Chemistry and ... (Biology or Physics or Geography, etc.)".

In the openings of the Book C Units, there is a large image covering two pages of the book with a brief text (half page) to introduce the theme of the Unit. The chapters start with the topic "In the News" that shows a journalistic text related to the theme to be covered. During the chapters, we observe text boxes, usually taking a whole page, with different titles: "Chemists' Routine" discusses chemical processes performed in the laboratory with specific apparatus; "Experiment" that proposes investigative experiments to raise questions and introduce a subject; "Curiosity" in which the authors present intriguing facts, historic events or extra discussions about the subject to make classes more fulfilling. During the chapter topics, exercises are proposed under "Questions" and/or "Chemistry and health" that contextualize Chemistry concepts with themes related to taking care of health. "Where from... where to?" discusses in a simple manner the use of raw materials. "Understanding the world" is the section that ends the Unit, concluding the theme that was discussed during the chapter followed by "Revision exercises".

In Book D, the chapter opening (covering two pages) shows a large illustration with a small text (half page) containing the themes that will be developed along the chapter. During the chapter, the authors provide several sections. "Activity" proposes experimental, research, text production activities among others, together with actions that promote a dialog between students. In the "Projects" section, the aim is to work the study theme in a broader manner. "Texts" proposes texts to close the section and "Activity" places questions about the reading or the activities. The book also contains other text material, i.e., taken from journals or the Internet. The "Questions" section features questions related to what was covered in "Text" or "Activity". In "Exam questions", there are questions extracted from university entrance exams and the ENEM. The "In the Internet", the section offers suggestions of websites relevant to the contents being studied.

In the face of those characteristics, we point out that Book A is the one that features the most complementary texts, information illustrations (pictures, tables, flow-charts) and reflection exercises about the themes linked to Environmental Education. Book B works on the theme more frequently than Book A by featuring reflection exercises and smaller texts, but with illustrations and representations that contextualize the contents. Books C and D, in addition to the texts, feature experiments and results to be analyzed and proposals for investigative experiments about the environmental issues.

CONCLUSIONS

The analysis carried out in this paper showed great advancement in the Brazilian TB relative to approaching the Environmental Education theme. In fact, it can be perceived that in the works examined, the theme in question was strongly present in all the books analyzed. Additionally, it is considered that the construction of expertise relative to Environmental Education requires the recovery and construction of values both within the school scope and the sphere of the community.

Is it believed that the TB, in an isolated fashion and out of context of the reality experienced by students, cannot develop environmental awareness in the learners and making them critical, ethical and responsible in relation to the environmental concerns that affect our planet. However, it is undeniable that these works are sources of important technical information and formal knowledge that together with the teachers' job of going deeper and reflection may lead students to a true awareness of environmental problems, thus implying the formation of an environmental citizenship that, in turn, may be a tool to harness the adoption of a sustainable way of life.

ACKNOWLEDGMENTS

Daniel das Chagas de Azevedo Ribeiro thanks the CAPES Foundation-Ministry of Education of Brazil for his postgraduate research grant (Process: AUX-PE-PROEX 1533/2013).

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Received 18-05-2015 /Approved 30-11-2016

La teoría del aprendizaje significativo en la enseñanza de las ciencias: ¿Una moda pedagógica más?

Meaningful learning Theory in science education: just another pedagogical trend?

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Resumen

El método de enseñanza más extendido hace unos años era el puramente receptivo, luego derivó al aprendizaje por descubrimiento (ya fuera causal, ya dirigido) y en la actualidad está ampliamente aceptado que el aprendizaje significativo es el sistema didáctico más eficaz. La cuestión es, ¿cuál será el método pedagógico de moda dentro de unos años?, ¿cuántos años durará esta moda de considerar el aprendizaje significativo como el mejor método didáctico? En el trabajo que presentamos hemos construido un razonamiento titulado "¿Es nuestro cerebro fisiológicamente constructivista?", con el objetivo de resaltar la necesidad del aprendizaje significativo en la enseñanza de las ciencias.

Concretamente, se pretende poner de manifiesto que el constructivismo no es una moda pedagógica más. Fisiológicamente, nuestro cerebro está constituido de forma que funciona buscando el significado de la información que le llega y, por tanto, el aprendizaje significativo no es una opción didáctica, sino una exigencia fisiológica de nuestro cerebro.

Palabras clave*: aprendizaje significativo, física, didáctica, constructivismo, ciencias*

Abstract

Fifty years ago the most widespread method of teaching was purely receptive. Discovery learning followed afterwards, and now is widely accepted that meaningful learning is the more effective educational system. What will be the preferred pedagogical method in a few years? How many years will be meaningful learning considered as the best teaching method? In this work we have constructed a reasoning which aims to highlight the need for meaningful learning in the teaching of sciences.

We want to show that constructivism is not just another pedagogical trend. Physiologically, our brain searches for the meaning of the information it receives, so meaningful learning is not a teaching option, but a physiological requirement of our brain.

The processes of visualization and conceptualization have many common characteristics. What is done in both is to abstract the constant features of either the objects or the objects or events and build either a visual world or a cognitive structure. We could therefore extrapolate what is known of the brain process of viewing to the brain process of conceptualization.

Key words: *meaningful learning, physics, didactics, constructivism, sciences*

INTRODUCCIÓN

Teorías de aprendizaje

Los enfoques constructivistas del aprendizaje se han ido constituyendo a partir de las investigaciones de Piaget sobre el desarrollo genético de la inteligencia (Piaget 1976; Piaget 1978). Las teorías de Piaget señalan el punto de partida de las concepciones constructivistas del aprendizaje como un proceso de construcción interno, activo e individual. Para este autor, el mecanismo básico de adquisición de conocimientos consiste en un proceso en el que las nuevas informaciones se incorporan a los esquemas pre-existentes en la mente de los alumnos, que se modifican y reorganizan según un mecanismo de asimilación y acomodación facilitado por la actividad de la persona. Piaget no pretendió que sus investigaciones tuvieran implicaciones educativas. Sin embargo, éstas eran inevitables, pues los conocimientos que se pretenden que aprenda el alumno tienen que adaptarse a su estructura cognitiva (Tünnermann, 2011).