Duart, J. & Lupiañez, F. E-strategias en la introducción y uso de las TIC en la universidad. *Revista de Universidad y Sociedad del Conocimiento*. ***2*** [1]. 5-30, 2005. .

EFMD-CEL Accredited. *EFMD CEL Criteria, Indicators and Standards teChnology-Enhanced Learning Accreditation*. 2006. Recuperado el 08 de septiembre de 2014 de www .efmd.org

Eraso, I., Paredes, H. & Insuasty, J. Resumen: Proyecto de Incorporación de TIC en la Universidad de Nariño. 2009.Fernández Batanero, J. M. & Torres González, J. A. Actitudes docentes y buenas prácticas con TIC del profesorado de Educación Permanente de Adultos en Andalucía. *Revista Complutense de Educación*, Núm. Especial, [26], 33 – 49, 2015.

Garzón Clemente, R. Public Policies for Information and Communication Technologies Inclusion in Mexican Higher Education. *Revista de Pedagogía*. **35** [97/98], 92 – 107, jun/jul 2015.

Almerich, G., Orellana, N., Suárez-Rodríguez, J. & Díaz-García, I. Teachers' information and communication technology competences: A structural approach. *Computers & Education,* **100**, 110-125, 2016.

Heitink, M., Voogt, J., Verplanken, L., Van Braak, J. & Fisser, P. Teachers' professional reasoning about their pedagogical use of technology. *Computers & Education,* **101**, 70-83, 2016.Khan, B. People, process and product continuum in e-learning: The e-learning P3 model. *Educational Technology*, 33-40, 2004.

Lu, C., Tsai, C.-C., & Wu, D. The Role of ICT Infrastructure in Its Application to Classrooms: A Large Scale Survey for Middle and Primary Schools in China. *Educational Technology & Society*, **18**, [2], 249–261. 2015.

Marquès Graells, P. Impacto de las TIC en la enseñanza universitaria. *DIM: Didáctica, Innovación y Multimedia*, [11], 2008.

Ministerio de Educación Nacional. *Ministerio de Educación Nacional*. 2010. Recuperado el 2 de octubre de 2014, de: http://www.mineducacion.gov.co/1621/w3-article-231240.htmlMinisterio de Educación Nacional. Revisión de marcos internacionales sobre estrategias de incorporación de TIC. 2014. Recuperado el 08 de septiembre de 2014, de: http://wikiplanestic.uniandes.edu.co/lib/exe/fetch.php?media=vision:modelos_internacionales_incorporacion_tic.pdf.

Moreno, B. & Mariano, F. Diseño Instructivo de Formación On-line, Barcelona: Ariel Educación. 2002.

Morrison, J. *Comprehensive Approach to Program Evaluation in Open and Distributed Learning (CAPEODL Model): An Interview with Badrul Khan.* 2004. Recuperado el 30 de Agosto de 2015, de: http://technologysource.org/article/global_elearning_framework/

NIACE. *The Adult and Community Learning (ACL) e-learning position statement (Elps)*. 2007. Recuperado el 22 de septiembre de 2015, de:http://www.niace.org.uk/current-work/the-adult-and-community-learning-acl-e-learning-position-statement-elps-tool

Ortiz de Zárate, A. Manual de uso del blog en la empresa: Cómo prosperar en la sociedad de la conversación, Barcelona, Zero Factory. 2008.

Peña Ochoa, P. & Peña Ochoa, M. A. El Saber y las TIC ¿Brecha Digital o Brecha Institucional?. *Iberoamericána de Educación*. 2007.

Reena Tok, B. & Sora, M. Perspective of Emerging Integrating Technology (ICT) in Learning and Teaching. *International Journal of Information and Education Technology.* **2**, [3] April. 2013.

Rogers, E. M. & Shoemarker, F. F. La comunicación de Innovaciones: Un Enfoque Transcultural, México: Centro Regional de Ayuda Técnica - Agencia para el Desarrollo Iternacional. 1974.

Salinas, J. Campus Extens. Un Modelo de Formación Flexíble en Entornos Virtuales. 2000. III Congreso Internacional de Comunciación, Tecnología y Educación. Redes Multimedia y Diseños Virtuales. Septiembre. Oviedo. Septiembre, 2000. Recuperado el 15 de marzo de 2016, de http://gte.uib.es/pape/gte/sites/gte.uib.es.pape.gte/files/Campus%20Extens-%20Un%20modelo%20de%20formaci%C3%B3n%20flexible%20en%20entornos%20virtuales.pdfSalinas, J. Innovación docente y uso de las TIC. *Revista de Universidad y Sociedad del Conocimiento,* **1,** [1], 1-16. 2004.

Salinas, M.I. Diseño de las políticas docentes para la adopción de una enseñanza virtual: El caso de un departamento universitario. 2010. Recuperado el 22 de septiembre 2015, de: http://edutec.rediris.es/revelec2/revelec33/

Sancho Gil, J. M. Las TIC en la universidad desde las experiencias de vida profesional de docentes e investigadores. *Instrumento*, **13**, [2], 23 – 34, , 2011.

Sandia Saldivia, B. Implantación y Validación del Modelo Organizacional y de Gestión para la Formación Flexible en la Universidad de Los Andes. Editorial Académica Española. Saarbrucken, Alemania. 2012.

Sandia Saldivia, B. Rostros y Modos de la Educación superior. Una Educación Universitaria de Calidad. Publicaciones Vicerrectorado Académico. Universidad de Los Andes. Mérida, Venezuela. 2015.

Sahasrabudhe V, & Kanungo S. Appropriate media choice for e-learning effectiveness: Role of learning domain and learning style. *Computers & Education,* **76**, 237-249, July 2014.

Scott Daniels, J., Jacobsen, M., Varnhagen, S. & Friesen, S. Systemic, Effective, and Sustainable Technology Use in High School Classrooms. *Canadian Journal of Learning and technology*, **39**, [4], Fall/automne. 2013.

Torres Velandia, S. Á., Barona Ríos, C., & García Ponce de León, O. Infraestructura tecnológica y apropiación de las TIC en la Universidad Autónoma del Estado de Morelos: Estudio de caso. *Perfiles educativos*, **32**, [127], 105-127. 2010.

UNESCO. Las Tecnologías de la Información y la Comunicación en la Formación Docente, Guía de Planificación. Ediciones Trilce. 2004.Universitaria Virtual Internacional. Plan Estratégico TICs. 2013. Recuperado el 10 de septiembre de 2014, de: https://www.uvirtual.edu.co/Documents/Documentos-Institucionales/PLAN-ESTRATEGICO-TICS.pdf

Received 7-05-2016 /Approved 15-05-2017

Analysis of scientific content on labels and their educational implications: the case of clothing

Análisis del contenido científico de las etiquetas y sus implicaciones educativas: el caso de la ropa

Angel Ezquerra, Belen Fernandez-Sanchez, Moisés Martín, Marina Magaña

Dpto. Didáctica de las Ciencias Experimentales, Facultad de Educación. Universidad Complutense de Madrid, Dpto. Espectroscopia Nuclear, Vibracional y de Medios Desordenados, Instituto de Estructura de la Materia, CSIC, Spain

angel.ezquerra@edu.ucm.es, belenfersan@gmail.com, mmarting16@gmail.com, mmaganar@edu.ucm.es

Abstract

This paper presents the results of the analysis of scientific content on labels of dress clothes. The study is focused on classifying information, determining the cognitive demands involved and evaluating the basic knowledge to which citizens of any country have to face in a daily process: the choice of clothes. The results indicate that there are many scientific-technical concepts around clothing, which seem to demand an increasingly specific training. Finally, we discuss the implications of these results for citizens' education as well as in its possible use as a reference for formal education.

Key words: *science literacy, science in everyday life, buying process, citizens' education, labeling.*

Resumen

En este trabajo se presentan los resultados del análisis del contenido científico de las etiquetas de prendas de vestir. El estudio se centra en la clasificación de la información, la determinación de las demandas cognitivas involucradas y la evaluación de los conocimientos básicos a los que los ciudadanos de cualquier país tienen que enfrentarse en un proceso cotidiano: la elección de la ropa. Los resultados indican que hay muchos conceptos científico-técnicos alrededor de la ropa, que parecen exigir un entrenamiento cada vez más específico. Finalmente, discutimos las implicaciones de estos resultados para la educación de los ciudadanos, así como en su posible uso como referencia para la educación formal.

Palabras clave: *alfabetización científica, ciencia en la vida cotidiana, proceso de compra, educación ciudadana, etiquetado.*

INTRODUCTION

Obtaining resources is a basic need for all living beings. This fact is so transcendent that, at times, human societies have been named in terms of how they acquired and managed these resources. We thus speak of societies as being hunter-gatherers, hunting, agricultural, bartering, and commercial…In our world people fundamentally acquire goods through the buying process. This daily task has turned into one of the structural characteristics of our way of life and culture (McCracken, 1989), and has reached such importance that we now speak about living in a consumer society. This phenomenon has been studied by diverse social sciences such as economics, sociology, history, psychology, anthropology, etc., and has given rise to new professional fields such as marketing and advertising.

The societal environment in which we live is now based upon science and technology as well. Our society is shaped by technological innovation to such an extent that the characteristics of our culture and its evolution could not be understood separately from the scientific-technological advances which systematically modify our world (Korotayev, Malkov, Khaltourina, 2006).

These factors –consumption on the one hand, and the presence of science and technology on the other– have been considered through a social prism. According to the results of surveys carried out by the FECYT (Fundación Española para la Ciencia y la Tecnología = Spanish Foundation for Science and Technology) on the social perception of science and technology, spontaneous interest in science and technology has significantly increased in the last few years in Spain (FECYT, 2015). Despite this favorable evalution, however, the survey also shows that almost half of the general population (47.1%) believes their science education levels to be low or very low. Be that as it may, this clearly demonstrates the need for ~~the~~ institutions to analyze how the general population perceives scientific subject matter~~s~~ and the value they assign to them.

This situation - interest in Science and Technology and the perception of little training - leads to the suggestion that there exists a need for what has been defined in didactical terms as scientific literacy. As has been indicated in various studies although expressed differently, this requirement originates in the science and technology present in everyday life (Linn, 2002). In other words, it seems that the interest and value that the general population grants to these issues is to a certain degree linked to their relevance to the tasks of everyday life (health, nutrition, consumption, the environment…).

The analysis of the relevant daily life situations presenting scientific-technological content shows that there is a multitude of such circumstances (Ezquerra y Fernández-Sánchez, 2014). Science can be found in advertising (Campanario, Moya y Otero, 2001; Pitrelli, Manzoli y Montolli, 2006; Belova, Chang y Eilks, 2015); in certain TV programs (Dhingra, 2003; Ezquerra y Polo, 2010); in some high impact news stories (Oliveras, Márquez, y Sanmartí, 2013; Halkia y Mantzouridis, 2005; Jiménez-Liso, Hernández, Lapetina, 2010); in the information provided by weather reports (Ezquerra y Pro, 2006); and in the science sections of the press (Halkia y Mantzouridis 2005; Jarman y McClune, 2007) amongst others. All of this scientific-technological content is put forth in mass media communication in informative, educational, advertising and entertainment areas. The presence of this content in the media and the way in which it is presented determines part of the general population's social perception of it (O'Sullivan, Dutton y Rayner, 1998).

Equally worthy of consideration however, is the content which is embedded in other sources such as social debate (Ezquerra, Fernandez-Sanchez y Magaña, 2015; Hadzigeorgiou, 2014); or all of the scientific and technological questions related to concerns such as medicine, health, the environment, and the buying process(Sørensen, Clement y Gabrielsen, 2012), amongst others.

All of these factors with scientific-technological content are of crucial importance to the world in which we live and form part of the elements which make up what a person should know about Science in order to understand his/her environment. In Experimental Science Didactics terminology, we would say that these are reference points for correct scientific literacy. In other words, to be capable of making decisions related to personal welfare, social welfare and environmental welfare (Harlen, 2001; Lemke, 2006). This implies the ability to single-handedly respond to the numerous situations which come up in a person's day to day life (Hogan, 2002; Kolstø, 2006; Lewis y Leach, 2006).

This aspiration is reflected in a great number of educational policy reports by organizations such as UNESCO (1994), International Council for Science (UNESCO-ICSU, 1999), and the Latin American States Organization for Education, Science and Culture (OEI, 2001), as well as in the positions of prestigious and influential professional associations which have fostered highly ambitious scientific and technological projects, such as the American Association for the Advancement of Science (AAAS, 1993), the International Technology Education Association (ITEA, 2000), or the National Research Council (NRC, 1996), amongst others.

The appropriate analysis of these issues however, is beyond the scope of just academic training (Cajas, 2001; Desautels y Larochetelle, 2003) and requires expanding research out of educational centers.

OBJECTIVES

In this context, it is of great interest to determine what people need to know, from a scientific point of view, in their day to day lives. Given the vast scope of this knowledge, this study has focused upon a specific context: the buying process and more specifically that involving clothing. The purpose of this analysis is to determine the scientific content present in the labeling of clothing and the way in which it can be categorized in terms of didactical concepts. The study centers on classifying information, determining the implied cognitive demands and assessing the basic knowledge people need to face in a process as mundane as choosing clothing.

In this manner, and from the viewpoint of scientific literacy, we intend to establish certain reference points to indicate the type of content faced by people all over the world. We believe that, in spite of significant proposals (p.ej. Membiela, 2002; Marco-Stiefel, Ibáñez y Albero, 2000), to date there are no clear reference points indicating what a person needs to know to be considered as scientifically literate.

Furthermore, and from a perspective closer to formal education, one of the main problems in the teaching of the sciences is the disconnect between the themes taught in class and the day to day reality of the students (Pozo y Gómez Crespo, 1998; Duggan y Gott, 2002). As such, we intend to examine how this content can be incorporated into the classroom.

We must also remember that the concern with regards to this content is not exclusive to the academic world. There are organizations such as the European Union which gather in its norms (EC/96/74) directives governing the information present in the labeling of textile products. Equally, we can find analogous examples in the legislations of all countries and in most cases, these legislative texts appear to suggest that citizens must not only be able to understand the information about the product but also participate in the management and supervision of consumer information. However, the achievement of this goal is impossible without knowing the effects of this content on the general population.

METHODOLOGY

Once the object of the study had been decided – clothing - the next step was to establish where to collect the data. Various sales outlets were analyzed in order to produce a list of the different commercial formats to be found internationally: department stores, specialized shops (work clothing, sports clothing, furriers…), fashion stores (boutiques, shopping malls), online stores and small traditional businesses.

Each type of establishment offers its own communication focal point. Hypermarkets provide a wide range of choice and allow customers to explore thousands of possibilities but typically have a sales force which is relatively untrained in the products they sell. Specialized stores and traditional businesses however, offer the possibility of personalized assistance. This is an important difference as the first step in the decision making process is identifying, classifying and understanding the significance of the provided information.

The data collection was carried out in different businesses in an attempt to cover all of the commercial possibilities and the range of existing products; furthermore, criteria of proximity and economy of effort were also taken into account. This represented more than 200 stores and close to a thousand different types of clothing. In truth, it is difficult to provide an exact figure as the last phases of research consisted more in screening and contrasting data to determine what was lacking rather than in accumulating more articles that had already been considered.

The clothing was subsequently grouped into five large categories in order to achieve a first classification (Table 1). This first classification was carried out so as to share out field work amongst the researchers and to do so reasons of functionality of the clothing were utilized. This division however, turned out to be more transcendent for the interests of the study than had been originally anticipated. The fact is that dress clothing is more often than not considered from a fundamentally esthetic viewpoint by both buyers and sellers which in turn leads to scant scientific-technical information. On the other hand the situation is different when it comes to sports or work clothing as it seems that their utilitarian nature requires a more detailed explanation of their characteristics.

The next step, carried out simultaneously, consisted in extracting the emergent information units in the labeling and classifying them in terms of their links to scientific and technical content. This permitted the establishment of the following categories: a) information referring to physical magnitudes and units: b) information referring to product composition: c) information referring to handling (washing, drying, ironing and dry cleaning); d) information referring to specific terminology. It was also possible to confirm that, in accordance with EC Directive/96/74 concerning textile denominations, all labels follow a similar model. It is also true that certain articles, such as sports and specialized clothing, offered extra information. This additional data was also taken into consideration and classified even though it did not appear in the mandatory labels.

Table 1. Classification of clothing

Category	Clothing
Clothing: casual, fashion…	Sweatshirts, shirts, sweatshirts, blouses, sweaters, trousers, skirts, leggings, dresses, undergarments, handkerchiefs, tops, belts, shoes, sports shoes, etc.
Sports clothing	Cycling (jerseys, cycling shorts, helmets…); athletics and running (caps, t-shirts, tights, running shoes…); mountain sports and skiing (coats, wind breakers, fleeces, boots, trekking footwear…); swimming and diving (bathing suits, bikinis, wet suits, caps...); etc.
Winter clothing	Jackets, coats, heavy jackets, umbrellas, raincoats, etc.
Work clothing	Coveralls, reflective vests, protective helmets, metallic protective clothing, anti-static clothing, Firemens' (fireproof jackets and pants); police (bulletproof vests, punctureproof gloves); military (cammies); protective footwear, etc.
Smart clothing	Clothing with biomedical sensors, corrective clothing and soles, anti-cellulite pants…

RESULTS AND DISCUSSION

The objective of this work is not to enumerate in detail all of the information units of a scientific nature which appear in labels but rather to reflect upon the knowledge necessary to apprehend this content. This is why the tables in this work only bring together some of these information units and more concretely those which appear most frequently.

Physical magnitudes and units

The main purpose of the *physical magnitudes and units* is to characterize the product using objective information. Contrary to what happens with food products, appliances and electronic devices (Ezquerra y Magaña, 2016), the content related to physical magnitudes which appears in the labeling of clothing and footwear is quite scarce. Within this group, we have identified two types of magnitudes: pre-established physical magnitudes and those of convenience. The pre-established physical magnitudes describe properties both universal and specific to the article in question using units previously established. On the other hand, the *magnitudes of convenience* are those which have been created to measure a concrete property of the product by way of a unit created *ad hoc*. In this study, this type of magnitudes appears especially in the labeling of sports and work clothing given that they present highly specialized properties. In Table 2 you can find examples of both pre-established magnitudes and magnitudes of convenience.

Upon examination of Table 2, we can say that the *pre-established physical magnitudes* are stable, homogenous and tend to use units of the International System. Within the *physical magnitudes of convenience* however, we find a maelstrom of units, some adimensional and frequently coming from the English speaking world. They present heterogeneous information, at times highly debatable, where there are no pre-established standards as to what to measure and which units to use. With some of these

Table 2. Physical magnitudes and units present in clothing

Category	Magnitudes	Units	Clothing
Pre-established physical magnitudes	Washing and ironing Tª	ºC, ºF	All but footwear
	Dimensions	cm, " (Inches)	Sports clothing
	Mass	kg, g	Sports clothing and footwear
Physical magnitudes of convenience	Impermeability	PSI (Pounds-force per square inch)	Sports clothing and work uniforms
	size	S, M, L, XL…	All but footwear
		36, 38, 40, 42…	
		37, 38, 39, 40, 41…	Footwear
	Breathability or RET (Resistant to evaporation transfer)	g/m2 in 24h	Sports clothing, work uniforms and footwear
	External fabric's resistance to water	Adimensional fraction	Sports clothing and work uniforms
	Wind resistance	CFM (Cubic feet per minute per squared feet)	Sports clothing and work uniforms
	Quality of feather filling	Cu ins (Cubic inches)	Sports clothing
	Percentage of filling	adimensional fraction	Sports clothing

measurements, the consumer is unable to contrast brands or models and can be at the mercy of the makers' fancy. Nevertheless these magnitudes and units can at times present information of great interest to the consumer. For example, the Spray Test is used to measure the waterproofness of a fabric in which 80/20 means that 80% of the material repels water after 20 washing cycles. In any case, these magnitudes of convenience seem to originate in the desire to familiarize the end user with the properties of the product. In other words, these magnitudes appear as a need for communication with the customer.

As for size—surely the magnitude we focus on primarily when buying--, this will vary depending on gender, country, maker and also the type of clothing. Nonetheless, in general, this magnitude is usually shown in an adimensional fashion using numerical systems (36, 38, 40…) or alphabetic (S, M, L, XL…). Obviously these correspond to units of the International System. For example, a woman's size 40 will indicate that a person has a bust size of approximately 91 cm, 71 cm waist and 99cm in the hips even though we must point out that nowadays women's sizes are a matter of great controversy. We would also add that this is the case in continental Europe whereas these dimensions would be a size 12 in the United Kingdom, a size 8 in the United States, 42 in Brazil or an 11 in Japan.

Composition

The composition of the different types of clothing and footwear vary extensively which has led to an ample and heterogeneous list of materials. We therefore opted for a classification in terms of origin (Table 3) be they natural (animal, plant or mineral) or synthetic (polymers). It must be pointed out that despite being of natural origin all the materials comprising the fabrics used in clothing have been processed. These different types of treatment however, either chemical or physical, are usually not taken into account. Elements such as thread size, number of fibers per surface unit, type of dye, etc., are usually omitted as well. All of these aspects speak of the characteristics of the product being bought and often are a mark of the quality of the fabric. These characteristics only came up in some of our conversations with shop assistants in traditional businesses.

Table 3. Composition of clothing

Origin		Materials
Natural	Animal	Wool, fur (mohair, cashmere…), skin-leather (bovine, ovine…), feather-down and silk.
	Plant	Cotton, hemp, linen, esparto, paper, raffia…
	Mineral	Fiberglass, asbestos (highly regulated use),
Synthetic (polymers)		Carbon fibers (P140), polystyrene, polyamide (nylon), polycarbonates (PC), polyurethane, polypropylene, neoprene, polytetrafluorethylene, PVC, rayón (viscose, acetate, cupro, polynosic), acrílic fiber, silicone, gortex, dyntex y aramids (meta and para), elasthene (spandex, lycra) y elastomultiéster.

In Table 3 we can observe that there is a great variety of types of synthetic materials as opposed to natural ones. Polymers, materials which revolutionized the textile industry in the first third of the twentieth century, used either individually or in combination, are present in the vast majority of fabrics used in clothing today.

This option of combining substances has allowed for an infinite number of possibilities in terms of proportions, composition and weave. It has generated a universe of options each with its own characteristics and properties. Furthermore, many of these polymers are named differently by different makers making it difficult for the consumer to discern which is which. In any case, the consumer is faced with cognitive demands coming from different fronts be they identifying the type of materials, recognizing their characteristics or properties, and having a handle on the proportions or percentages of composition.

Processes

The analysis of the labeling of clothing and footwear demonstrates the existence of a great amount of information referring to processes. These are of two types: how was the fabric made and how it must be maintained. The first, the making of the fabric, does not require any action from the customer but rather is linked to an understanding of the quality and properties of the article of clothing. The second element of this classification however, the maintenance of the article in question, does make a procedural demand: the user must take concrete steps. Table 4 is just a sample of the procedural content classified in terms of ironing, washing, drying or dry cleaning.

Table 4. Procedures present in clothing

Subcategory	Process
Ironing	Iron at x ºC (ºF).
	No hot air.
	(no) steam ironing.
Wash	Wash at x ºC.
	Wash at low temperature.
	Wash with reduced moisture.
Dry	Use dryer at x ºC.
	Do not sundry.
	Dry without heat.
Dry-cleaning	(No) Use of mineral essences.
	(No) Use of perchloroethylene.
	(No) chlorine based bleach.
	(No) oxygen based bleach.
	(No) Use of ordinary thinner.

These four procedural categories appear in all of the labels of the analyzed products which underlines the need for the consumer to understand concepts such as temperature (º C, ºF) or the command “Do not use perchlorethylene”; “ iron with (without) steam” or to know which chemical products to use in dry-cleaning the product. Moreover, the symbols used in labeling to identify these procedures can be too technical for most consumers.

Specific terminology

Specific terminology is essentially found in the labeling of specialized clothing (sports, work and smart clothing). The content found (Table 5) was interesting and gives an idea of the huge diversity of circumstances in which science and technology appear in people’s lives. Furthermore, much of this terminology is eye-catching and could stimulate students’ interest and as such would be a magnificent starting point or connection between the classroom and certain appealing work environments.

Table 5. Specific terminology presents in clothing

Specífic terminology	Clothing
Infrared treatment.	Military uniforms
Antimicrobe and antibacterian treatment of silver nanoparticles.	Military caps
Reflective material made of retro-reflective wide angle lenses.	Reflective vests
May contain ceramic layers and light steel for increased protection.	Bulletproof vests
Anti-mist and anti-ultraviolet ray treatment of visor.	Cycling helmets
Combines caffeine, retinol, vitamin E, aloe vera and fatty acids incrusted or encapsulated in fibers.	Anticellulíte pants
anti-static threads	Anti electricity t-shirts and boots

IMPLICATIONS

The analysis of the information appearing in the labeling of clothing allows the confirmation that there is scientific content which can be classified into four categories: *physical magnitudes and units (pre-established and of convenience), composition, processes and specific terminology*. Each one of these categories requires a specific didactical outlook within formal education – in the classroom – and a separate level of action/intervention in the general population.

Didactical implications

From a didactical viewpoint and in a synthetic fashion, the pre-established *physical magnitudes and units* are stable and homogeneous which facilitates their selection and academic use in the classroom. On the other hand the *magnitudes of convenience,* which are more creative, allow us to introduce an element of educational interest not often seen in the classroom, namely creativity. They would also make it easier to give students real examples of how units are developed, estimations are done and how analogies are sought amongst measurements. These facts offer an excellent opportunity to carry out verification tests and promote the measurement of elements of daily life for students.

In relation to *composition,* activities connected to polymers and the proportions in which they are found could be carried out: what are polymers, how are they synthesized, what are their structures, what are they used for, in what percentage, evolution throughout history, etc. The objective would not be to train students to be experts in the textile industry but rather people who understand the difference between different types of fabrics and why some are used and others not in the making of particular articles of clothing.

For its part, the *processes* category brings together the actions which are asked of, or recommended to, the user (ironing, washing, drying, cleaning…). These instructions concentrate conceptual demands (temperature, perchlorethylene…), action protocols (dry-clean with reduced moisture…) and should generate curiosity about why one must take this action and not another. This seems to facilitate minor research projects in the classroom. Finally, within the *specific terminology* category, there are thought stimulating questions which would be a magnificent starting point to connect the classroom with the latest scientific-technological advances.

One interesting fact we were able to ascertain is that scientific and technical contents often appear mixed together whereas in formal training they are broken down into distinct bodies of knowledge: mathematics, physics, chemistry, technology…This is an example of how reality does not establish borders between fields of knowledge whereas this is par for the course in the curriculum of almost every country's educational organization. In our opinion, this fragmentation hinders the students' understanding of the sciences in the way they will perceive them in reality and in the way they will use them in their daily lives. The classroom should offer students the opportunity to appreciate Science in the way it affects their daily lives through the analysis of commonplace products which are so easy to acquire (Gomes, Dionysio, Messeder, 2015).

An interesting proposal for students carrying out minor research projects, either individually or in small groups of 3 to 5 people, would be to start again and gather all relevant information from the labels for later analysis. The following points can be incorporated:

Price and materials used comparison of different articles of clothing.

Correlation between different magnitudes related to sizing: measurement of the article of clothing in cm, proportion between measurements of different parts (back width, inseam, waist circumference…), etc.

Measurement of the impermeability of different fabrics and their degree of resistance to water as hands-on laboratory work.

A reflection upon the role of advertising in consumer habits and decision making when buying clothes. Prompted questions might be; "Why is one article of clothing more expensive than the other when both are made of the same material?" or "What factors come into play when choosing clothing". Critical thought amongst students is thereby encouraged by reflecting upon the role played by advertising in general and the scientific content present in advertisements in particular (Belova and Elks, 2014).

Activities of this type are currently underway and their assessment will be the subject of future work.

These ideas with regards to the classroom are clearly mere suggestions and require consolidation. They need to be tailored to the curriculum of each country, made explicit for each educational level, detailed in planned activities and finally the results of their implementation need to be analyzed. In any case, the reality which surrounds us all – and ultimately our students – must serve as a reference point for the curricula of all countries as we have suggested. These tasks, however, remain pending for future efforts.

Training of the general population

The identification of scientific-technological content and the analysis of training demands stemming from the buying process are not only academic reference points in any educational system but are also elements which give form to the concept of scientific literacy. The Didactics of Experimental Sciences have been promoting these training demands as a way to develop the skills and competencies necessary to a full expression of citizens' rights (Prieto, España y Martín, 2012). Thus, focusing our thoughts upon the general population and using the gathered information as a starting point, it seems that the different contents present in the buying process of clothing generate highly varied cognitive demands.

By way of example, the *magnitudes and units* category require of the individual a conceptual understanding of physical properties and a certain degree of procedural capability to measure and compare whereas *composition* and *specific terminology* seem to contain exclusively conceptual requirements. The category of *processes* demands a specific mode of intervention, a protocol of action by the consumer.

It is also of interest to point out that very few allusions to the environment and sustainable development were found in clothing labels which is somewhat surprising given the common use of materials of animal origin in the making of clothing. Only one case was found alluding to "le pelli impiegate non appartengono inoltre specie di animale protette" [No animal skins of protected species were used]. It is possible that if the labels found in furriers had been analyzed, more information units of this type would have been found. Neither was information on the possible use of recycled materials or the ecological footprint found. However, some examples referring to the non-artificial origin and non-toxicity of substances used were identified but given the limited number of these, it was not possible to group them together into a category. Terms such as "bio cotton", "100% natural wool". "natural dye", "contém partes não têxteis de origem animal", or "tested for harmful substances" were found but these seem to be expressions used for advertising purposes as opposed to reliable information. This information should be demanded by consumers and made mandatory by the competent administrations.

In any case, everyone, and everywhere, is exposed to an incessant deluge of scientific-technological content. This is why, as stated by Rio (1986), education plays—or should play—a decisive role in consumer based societies.

CONCLUSIONS

The aim of this work has been to analyze how Science is present in everyday life, to specify this presence through the collection and classification of scientific-technological content found in a process as mundane as the purchasing of clothing and to consider, as a first step, the cognitive consequences both for the classroom and the general population. Undoubtedly, there is still a long way to go. A multitude of questions arises: what is the complete array of scientific contents to be found in daily life, what cognitive demands do they give rise to, how can we train people to face these demands once formal education has come to an end, what impact does this knowledge have upon the work life and personal life of the individual, how can we analyze these facts, etc. All in all, we consider that the study of how science is present in society, and more particularly the study of the factors which determine this reality, must constitute a line of research from the vantage point of the didactics of the experimental sciences (Pro y Ezquerra, 2005).

BIBLIOGRAPHY

AAAS. *Benchmarks for Science Literacy: A project 2061 report on literacy goals in Science, Mathematics, and Technology.*. New York: Oxford University Press, 1993.

Belova, N., & Eilks, I. Using advertisings to introduce inquiry and societal oriented science education. Centre for Educational Policy Studies Journal, **4**, 32–49, 2014.

Belova, N., Chang Rundgren, S. N., & Eilks, I. Advertising and science education: a multi-perspective review of the literature. *Studies in Science Education*, **51** [2], 169-200, 2015.

Cajas, F. Alfabetización científica y tecnológica: La transposición didáctica del conocimiento tecnológico. *Enseñanza de las Ciencias*, **19**, [2], 243-254, 2001.

Campanario, J.M.; Moya, A.; Otero, J. Invocaciones y usos inadecuados en la ciencia en la publicidad. *Enseñanza de las Ciencias*, **19**, [1], 45-56, 2001.

CE/96/74. Directiva 96/74/CE del Parlamento Europeo y del Consejo de 16 de diciembre de 1996 relativa a las denominaciones textiles.

Desautels, J.; Larochelle, M. Educación científica: el regreso del ciudadano y de la ciudadana. *Enseñanza de las Ciencias*; **21**, [1], 3-20, 2003.

Dhingra, K. Thinking about television science: how students understand the nature of science from different program genres. *Journal of Research in Science Teaching*, **40,** 234-256, 2003.

Duggan, S.; Gott, R. What sort of science education do we really need? *International journal of science education*, **24**, [7], 661-679, 2002.

Ezquerra, A.; Magaña, M. A comprar comida... ¿con los apunte de clase? *Alambique*, **84**, 61-66, 2016

Ezquerra, A., Fernandez-Sanchez, B. y Magaña, M. Qué contenidos científicos proponen los partidos políticos y su repercusión en la alfabetización científica de la ciudadanía. Estudio sobre el tópico "energía". *Revista Eureka sobre Enseñanza y Divulgación de las Ciencias*, **12**, [3], 491-507, 2015.

Ezquerra, A.; Fernandez-Sanchez, B. Análisis del contenido científico de la publicidad en la prensa escrita. *Revista Eureka sobre Enseñanza y Divulgación de las Ciencias*, **11**, [3], 275-289, 2014.

Ezquerra, A.; Polo, A. Una exploración sobre la televisión y la ciencia que ve el alumnado. *Revista Electrónica de Enseñanza de las Ciencias*; **9**, [3], 684-703, 2010.

Ezquerra, A.; Pro, A. Posibles usos didácticos de los espacios meteorológicos de la televisión. *Revista Electrónica de Enseñanza de las Ciencias*, **5**, [1], 114-135, 2006.

FECYT. *Percepción Social de la Ciencia y la Tecnología.* Fundación Española para la Ciencia y la Tecnología, FECYT, 2015.

Gomes, L.; Dionysio, L.; Messeder, J. Análise de rótulos de produtos domissanitários como forma de discutir a química no cotidiano dos estudantes. *Educacion química*; **26**, [1],. 21-25, 2015.

Hadzigeorgiou, Y. A Critique of Science Education as Sociopolitical Action from the Perspective of Liberal Education. *Science and Education*, **24**, 259-280, 2014.

Halkia, K.; Mantzouridis, D. Students' views and attitudes towards the communication code used in press articles about science. *International Journal of Science Education*, **27**, [12], 1395–1411, 2005.

Harlen, W. The assessment of scientific literacy in the OECD/PISA project. *Studies in Science Education*, **36**, 79-104, 2001.

Hogan, K. Small groups' ecological reasoning while making an environmental management decision. *Journal of Research in Science Teaching*, **39**, [4], 341–368, 2002.

ITEA. *Standards for technological literacy: Content for the study of technology.* Reston, VA: International Technology Education Association, 2000.

Jarman, R.; Mcclune, B. *Developing scientific literacy. Using news media in the classroom*. Maidenhead: McGraw-Hill International, 2007.

Jiménez-Liso, M.R.; Hernández, L.; Lapetina, J. Dificultades y propuestas para utilizar las noticias científicas de la prensa en el aula de ciencias. *Revista Eureka sobre Enseñanza y Divulgación de las Ciencias*, **7**, [1], 107-126. 2010

Kolstø, S. Patterns in Students' Argumentation Confronted with a Risk-focused Socio-scientific Issue. *International Journal of Science Education*, **28**, [14], 1689-1716. 2006.

Korotayev A.; Malkov, A.; Khaltourina, D.. Introduction to Social Macrodynamics: Compact Macromodels of the World System Growth. Moscu: Editorial URSS. 2006.

Lewis, J.; Leach, J. Discussion of Socio-scientific Issues: The role of science knowledge. *International Journal of Science Education*; **28**, [11], 1267-1287. 2006

Lemke, J. Investigar para el futuro de la educación científica: Nuevas formas de aprender, nuevas formas de vivir. *Enseñanza de las Ciencias*; **24**, [1], 5-12. 2006

Linn, M. Promover la educación científica a través de las tecnologías de la información y comunicación (TIC). *Enseñanza de las Ciencias*; **20**, [3], 347-355. 2002.

Marco-Stiefel, B., Ibáñez, T. y Albero, A. *Diseño de Actividades para la Alfabetización Científica. Aplicaciones a la Educación Secundaria.* Madrid:Narcea Ediciones. 2000.

McCracken, G. Who is the Celebrity Endorser? Cultural Foundations of the Endorsement Process, *Journal of Consumer Research*, **16**, 310-321. 1989.

Membiela, P. Investigación-acción en el desarrollo de proyectos curriculares innovadores de Ciencias. *Enseñanza de las Ciencias*, **20**, [3], 443-450. 2002.

NRC. *National Science Education Standards*. Washington, DC: National Academic Press, 1996.

OEI. *Memoria de la programación 1999-2000*, Madrid: OEI. 121-134, 2001.

Oliveras, B., Márquez, C. y Sanmartí, N. The use of newspaper articles as a tool to develop critical thinking in science classes. *International Journal of Science Education*, **35**, [6], 885-905, 2013.

O'Sullivan, T.; Dutton, B.; Rayner, P. *Studying the Media: An Introduction.* London: Arnold, 1998.

Pitrelli, N., Manzoli, F. y Montolli, B. Science in advertising: uses and consumptions in the Italian press, *Public Understanding of Science*, **15**, 207-220, 2006.

Pozo, J.I.; Gómez-Crespo, M.A. *Aprender y Enseñar Ciencia.* Madrid: Morata, 1998.

Prieto, T.; España, E.; Martín, C. Algunas cuestiones relevantes en la enseñanza de las ciencias desde una perspectiva Ciencia, Tecnología y Sociedad. *Revista Eureka sobre Enseñanza y Divulgación de las Ciencias*; **9**, [1], 71-77. 2011.

Pro, A.; Ezquerra, A. ¿Qué ciencia ve nuestra sociedad? *Alambique: Didáctica de las Ciencias Experimentales*, **43**, 37-48. 2005

Río, P. Publicidad y consumo, hacia un modelo educativo. *Infancia y Aprendizaje: Journal for the Study of Education and Development*, **35**, 139-174. 1986.

Sørensen, H., Clement, J. y Gabrielsen, G. Food labels – an exploratory study into label information and what consumers see and understand. *The International Review of Retail, Distribution and Consumer Research*, **22**, 101-114, 2012.

UNESCO. Science and Technology 2000+ Education for all. The Project 2000+ Declaration. París: UNESCO, 1994

UNESCO-ICSU. *Proyecto de programa en pro de la ciencia: Marco general de acción*. Conferencia Mundial sobre la Ciencia para el Siglo XXI: Un nuevo compromiso, Budapest (Hungría), 26 de junio-1 de julio de 1999.

Received 11-05-2016 /Approved 15-05-2017

The Brazilian scientific literacy in the PISA
La alfabetización científica brasileña en el PISA

Muri, Andriele Ferreira Ortigão, Maria Isabel Ramalho

Pontifical Catholic University of Rio de Janeiro, University of the State of Rio de Janeiro, Brzil
isabelortigao@terra.com.br, andriele.muri@yahoo.com.br.

Abstract

This study investigated the scientific literacy of Brazilian students through the data of the Programme for International Student Assessment - PISA. Starting from the importance and relevance of discussing the Brazilian scientific literacy it sought to answer to two questions: (a) where are the Brazilian students located in the international context in terms of scientific literacy of PISA?; (b) how do Brazilian students' contextual characteristics, such as their school administrative dependence and socio-economic status, impact their results in Science? For the study, in addition to the determination of descriptive statistics, the analyses were conducted by applying a linear regression model. The results of the 2006 PISA showed that Brazilian students not enrolled at a private school and who do not come from a high-income family have a considerable disadvantage in science. It also showed that the fact of their school being public is alone substantially enough to explain more than 20% of the variance of the average performance in science of Brazilian students and corroborates the results of numerous other studies in educational equality / inequality.

Key words: *international evaluation, scientific literacy, Brazil, PISA*

Resumen

Este estudio investigó la formación científica de los estudiantes brasileños a través de los datos del Programa para la Evaluación Internacional de Alumnos - PISA. Partiendo de la importancia y relevancia de discutir la alfabetización científica brasileña se trató de responder a dos preguntas: (a) cómo son los estudiantes brasileños ubicados en el contexto internacional en cuanto a la formación científica de PISA?; (b) las características contextuales de los estudiantes de Brasil, tales como la dependencia administrativa de su escuela y su estatus socioeconómico, impactan sus resultados en Ciencia? Para el estudio, además de la determinación de la estadística descriptiva, los análisis se llevaron a cabo mediante la aplicación de un modelo de regresión lineal. Los resultados del PISA 2006 mostraron que los estudiantes brasileños que no están inscritos en una escuela privada y que no provienen de una familia de altos ingresos tienen una desventaja considerable en Ciencia. También puso de manifiesto que el facto de ser alumno de la escuela pública es suficiente para explicar en más de 20% la varianza del rendimiento medio en ciencias de los estudiantes brasileños y corrobora el pozo encontrado por otros numerosos estudios en igualdad / desigualdad educacional.

Palabras clave: *evaluación internacional, alfabetización científica, Brasil, PISA*

INTRODUCTION

The Brazilian Association of Science (2008) states that the social, scientific and technological development of Brazil requires a major overhaul of the educational structure in the country. The need to improve basic education in Brazil and, in particular, science education, was a central theme of the document of the Brazilian Academy of Sciences - Science Education and elementary school: proposals for a system in crisis - published in 2008 (ABC, 2008). It is believed that in order to meet the demands of an increasingly complex society, permeated by science and technology, technically specialized knowledge is not enough. Above all, the development of skills to organize thinking, make decisions and deal with data, for example, are crucial to take part in the field of Science. Science and technology define the future of a society and its ability to create and adapt technologies developed from different backgrounds. Even with all the development of science and technology and, although Brazil contributes about 2.7% of the world's scientific production, research conducted in the education field points to a below average performance of Brazilian youth in tests that measure scientific skills and performance in mathematics.