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Analysis of Scientific Language of Household Cleaning Products' Labelling and Its Educational Implications

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ABSTRACT

The necessity of an adequate scientific literacy among the population in general and students in particular is a fact. Two of the main obstacles in science education that hinder it are the lack of connection between the contents worked in class and the students' day-to-day, and the misunderstanding of scientific language. In the present study, a categorization and analysis of the scientific content of labelling and packaging of household cleaning products is presented. For that, we collected information from more than 500 items from 10 different countries and analysed it through a methodology based on a content analysis of a written text. According to the criteria used –the comparison of each of these contents with the different contexts and knowledge set by the OECD in the 2015 PISA Science Framework- we classified and analysed the information collected according its type of information, obtaining different categories: information referred to physical units, composition of the product, procedures, security instructions, environmental specifications and advertising information. The results and discussion describe the mentioned categories in which this information is classified, and regarded to the type, function, and form of language used in each one. Finally, some important social implication and consequences concerning to the language used in household cleaning products are highlighted in the conclusions. Complementarily, some general recommendations of how to work these contents in class are sketched out.

Keywords: scientific literacy, scientific language, labelling, household cleaning products

INTRODUCTION

Since science and technology are completely immersed in our lives, it could be unimaginable to conceive our day-to-day without all the scientific and technological developments. From the satellites that take pictures of the Earth, to the smartphones that allow us to check it. These advances have drastically changed different areas of our society, which include communication, transportation, medicine and leisure, among others. Their influence within the household environment is also evident, where its implementation is mostly related to the simplification of the domestic chores. For

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instance, in the 19th century, laundry was done by the riverside using a wooden washboard and a bar of soap, while now it is easily done at home with a washing machine and detergent.

Given the great amount of scientific contents present in our daily lives, population has to have a minimum understanding of the basic scientific concepts and processes in order to act coherently and successfully face the situations where science and technology are involved. This is known as scientific literacy (Miller, 1983; Kolstø, 2006; Lewis & Leach, 2006). Achieving the scientific literacy among the citizenship is absolutely necessary due to a wide range of reasons: economic -scientific and technological development of a country or region-; political and social -democratic understanding and participation in science and technology issues-; cultural -understanding the scientific knowledge as an essential part of the culture-; and functional –necessity to understand and cope with today's world- (DeBoer, 2000; Hodson, 2003; Bybee, 2008). Accordingly, the scientific literacy term can be analysed from two perspectives: the macro, related to a global benefit for the nation or society, and the micro, which concerns the improvement of the individual's quality life (Laugksch, 2000); in other words, under both the social and the personal point of view (Harlen, 2001).

The growing concern of society in achieving the scientific literacy has resulted in the publication of a high number of declarations and congresses considering this issue (e.g. OECD, 2007; UNESCO 2008). Specifically, the European Parliament approved the European Framework for Key Competences for Lifelong Learning that established eight key competences for lifelong learning, which includes the scientific competence (EC, 2006). Furthermore, in formal education, most European schools curricula follow this educational perspective with the aim of succeeding in the acquisition of a proper scientific literacy from the early educational stages (COSCE, 2011).

However, despite the numerous efforts made by the educative community, the current situation in science education does not meet the proposed objectives. Concretely, there are a high percentage of students who are quite far from succeeding in the acquisition of the adequate level of scientific literacy (Osborne & Dillon, 2008; Martin, Mullis, Foy & Stanco, 2012). There are several reasons that could explain such results; however, two of the main difficulties that have been identified in science education are the lack of motivation of students (Tuan, Chin & Shieh, 2005) and miscomprehension of scientific language (Mercer, Dawes, Wegerif & Sams, 2004; Aikenhead, 2005; Sjøberg & Schreiner, 2010; Osborne & Collins, 2001).

Among other reasons, students' lack of motivation might be associated to the disconnection between topics studied in class and their everyday life (Duggan & Gott, 2002; Stuckey, Hofstein, Mamlok-Naaman & Eilks, 2013; Clegg & Kolodner, 2014). Regarding this matter, Tuan & Chin (2000) demonstrated that concrete, perceptual and relevant science contents improve students' motivation when learning science. Therefore, it may be necessary to connect the contents studied in science class with the students' everyday life.

Concerning to the scientific language, several studies agree that language learning is an essential component when learning science in general (Wellington & Osborne, 2001; Brown & Ryoo, 2008) and chemistry in particular (Taber & García Franco, 2010; Song & Carheden, 2014; Childs, Markic & Ryan, 2015). As mentioned before, language is a great obstacle to most students when learning science (Wellington & Osborne, 2001). Concretely, the symbolic characters of chemical language may be considered as a significant contribution to its abstract nature (Beek & Louters, 1991;

Taskin & Bernholt, 2014). In addition, Pyburn, Pazicni, Benassi & Tappin (2013) have identified a relation between succeeding in completing a general chemistry course and the chemical language understanding.

Purpose

Under these circumstances, it is necessary to analyse the everyday situations related to scientific connotations and examine in detail the language used in those contexts. But to carry out this type of analysis, the first step is to leave the classroom, accompany the citizens in their day to day and analyse all the actions carried out from the perspective of the Teaching of Experimental Sciences (Pro & Ezquerra, 2004). By taking into account this information, we could establish references that indicate what kind of content should appear in the science curriculum and guide academic activities to suit the family situations for students. Once the scientific content is identified, it is possible to define the cognitive demands required by individuals in general and students in particular, for taking a well-founded decision. However, due to the immense amount of contexts, elements and contents where science is presented, we find it necessary to limit the scope of this work. Specifically, for this study, we have chosen one single context –the home science–, one element –the household cleaning products– and one written content –the information of the packaging and labelling of those products.

The reason why we chose this information is because household cleaning products are in every house and they are familiar to both citizens and students. Therefore, the use of this content can be used to work activities based on real life problems and connect the barrier between the real word and the classroom (Pine et al., 2006; Akçay, 2009). In addition, these products show interesting information for our aims on their labelling or packages, such as their chemical composition, safety instructions and conservation standards. These three aspects are regulated by the European Commission according the CE nº 1272/2008. In addition, most of this information is related to science. Regarding to this, a special Eurobarometer about consumer understanding of labels and the safe use of chemicals indicates that a sizeable number of respondents are unable to identify everyday household chemicals as chemical products. Moreover, 33% of respondents do not read the safety instructions before using a chemical product, and only 7% of those who read the instructions follow them fully. Under such circumstances, one of the conclusions of this special Eurobarometer is that further education regarding chemical products and their safety issues is needed (EC, 2011).

Taking these points into account, the objectives of the present study are:

1. To identify and categorize the scientific contents of labelling and packaging of household cleaning products.
2. To analyse the scientific language for each of these categories.
3. To connect and evaluate the importance of the language used in labels with the scientific literacy term and to evaluate some further social implications
4. To correlate and evaluate the importance of the language used in labels with scientific literacy and evaluate further some social implications (advertisement moral, critical purchasing, false public beliefs…)

Complementarily, some ideas of how to work these contents in class are proposed.

METHOD

a) Data collection

The information used for the study was obtained from labelling and packaging of household cleaning products of different countries (by alphabetical order): Belgium, Denmark, France, Germany, Italy, Poland, Portugal, Rumania, Spain and United

Kingdom. There were no significant differences between the information displayed in the same products of different brands and countries. Around 500 products from 10 different countries were analysed.

It has to be taken into account that the information collected from these labels was translated into English in order to complete the categorization. Thus, the information presented here does not reproduce them literally since they were written in different languages.

b) Data analysis

The methodology used to analyse the information presented in these labels was a content analysis of written text (Krippendorf, 2004). In order to isolate the scientific content of the units of information presented in these labels, we selected the information criteria to consider whether a content appearing on labels could be considered scientific or not. For that, we compare each of these contents with the 2015 PISA Science Framework (OECD, 2013). In this framework, scientific competence may be characterized as consisting of the next connected aspects: contexts, knowledge, competencies and attitudes. For this work, we took into account the different contexts and knowledge set by the OECD.

According to this framework, contexts are chosen according to the relevance to students' lives. Among all of them, we have selected those related to the topic of this study, the household cleaning products: *health (maintenance of health, accidents); natural resources (personal consumption of material and energy); environmental quality (use and disposal of materials and devices); and hazards (risk assessments of lifestyle choices*). In relation to knowledge about the natural world -or knowledge of science-, PISA selects the items according to their relevance to real-life situations within the next categories: p*hysical systems (properties of matter, chemical changes of matter);* l*iving systems (human health)*; and t*echnology systems (optimization, costs, benefits, risks)*.

Regarding to this, we were able to select a set of information units classified into several emerged and not exclusive categories: information referred to physical units, information referred to the composition of the product, information referred to procedures, information referred to security instructions, information referred to environmental specifications and information with advertising information.

In this way, information referred to physical units and composition is related to physical systems. All the contents referred to procedures and security instructions – *avoid contact with skin, do not ingest, do not mix with other products*, etc. - are related to the maintenance of the health and the avoiding of accidents. The information referred to environment specifications, as well as the one with advertising intention may be associated with the personal consumption of materials and energy, as well as to the environmentally friendly behaviour.

RESULTS and DISCUSSION

A detailed description and discussion of the information gathered from the labelling and packaging of household cleaning products of 10 different countries is described following the above-referred classification.

a) Information referred to physical units

This section shows objective information about features of the product. In the analysis process, it was observed that these units could be classified as predefined physical units and units of convenience.

The predefined physical units (Table I) are homogeneous and firmly established. Within this category, two types can be identified: the words themselves (density, concentration, conductivity…) and the symbols of the units. Each of these subcategories –words and symbols- has a different type of language. Each type of language used in science requires different cognitive demands on the individuals (Wellington & Osborne, 2001), and therefore it requires different cognitive demands on the consumers.

Table 1. *Information referred to predefined physical units*

Magnitude [unit]	Examples of some products
Mass [mg; g; kg]	Washing up liquid, dishwasher powder, detergent, bleach
Volume [L; mL; cm^3; pint]	Washing up liquid, bleach, floor cleaner, ironing water, glass and window cleaner
Density [g/mL; kg/L]	Washing up liquid, WC cleaner
Concentration [%; mg/L; g/mL]	Dishwasher, detergent
Temperature [ºC; ºF]	Detergent, dishwasher
Time [min; weeks; months; years]	Dishwasher, floor cleaner, window and glass cleaner
Distance [cm; mm]	Window and glass cleaner
Conductivity [µS]	Ironing water
pH [dimensionless]	WC cleaner, furniture cleaner
Acidity [%]	Plughole unblocked bathroom

Some of these units are well-established in our day-to-day (e.g. time or distance), so individuals should not find difficulties in understanding them. On the other hand, there are other units that, despite of being commonly used, may have dual meanings when used in colloquial or scientific language. According to several studies (e.g. Beck, McKeown & Kucan, 2002; Lee, Quinn, & Valdés, 2013) individuals tend to confuse both meanings. For instance, "heat" is used as synonymous of "high temperature" (Jasien & Oberem, 2002; Brookes & Etkina, 2015); "mass" is used as synonymous of "weight"; the word "acidity" is also used in colloquial language as sharp-tasting or sour, while in chemistry is used as the amount of acid present in a solution, often expressed in terms of pH. Usually, students do not identify the scientific meaning of this type of words, although the context where they are used is completely different. This highlights how language can be barrier to learning (Wellington & Osborne, 2001; Brown & Ryoo, 2008).

Another point to take into account is the use of different units to measure the same magnitude (e.g. volume in "cm^3" and "ml", concentration in "mg/L", "g/100g" and "%"), which may cause difficulties and doubts in individuals. Likewise, it is also common to use the same units for different magnitudes (e.g. "%" to measure concentration and acidity; or "g/mL" to measure both concentration and density). Therefore, products that do not specify the magnitude that is being measured may be misleading.

Another kind of units has been identified and, because of their special features, we named them *units of convenience* (Table II). These terms are heterogeneous and seem to be created with the aim of measuring specific properties of the product by a unit created ad hoc. The language used in this type of units present a more familiar approach in order to facilitate its understanding to the consumers (e.g. measuring the volume of a detergent in *number of washings* instead of litres). It is worth mentioning that they do not follow pre-established rules. Therefore, the *units of convenience* try to bring scientific concepts and consumers closer.

Some of these *units of convenience* are widespread, for instance, measuring quantities in number of cups or tablets ("two caps, one tablet") as commonly observed in detergents for dishwashers and washing machines. However, there are others that

are more whimsical, such as the level of the detergent concentration ("850 g normal detergent= 650 g concentrated detergent = 10 washes").

Table 2. *Information referred to units of convenience*

Magnitude [unit]	Examples of some products
Quantity [cap, washes, tablet, bucket, washing]	Dishwasher, floor cleaner, bleach
Concentration [ºF]	Dishwasher, detergent
New concentrated: 850 g = 650 g = 10 washes	Concentrated detergent
Water hardness [soft, medium and hard]	Detergent
2 caps (60 ml) in 5L of water	Floor cleaner

b) Information referred to composition of the product

Contrary to labelling of food, cosmetics and personal hygiene products, the legislation for household cleaning products do not oblige to show the complete composition, but only quantitative margins of the active substances, and other components of particular interest due to of their effect on environment or the presence of allergens (see section *information referred to security instructions*), among others.

When classifying this information (Table III), we realized that products used for different purposes have a very similar composition, since they share most of the active ingredients such as surfactants. Within the same kind of products, this similarity is further exacerbated, up to the point that some products of different brands have the same composition.

Most of these contents are technical words rarely used in colloquial language. Therefore, in order to succeed in the communication process, a connection should be stablished between the understanding of these words and the products' properties. However, sometimes it is not easy to find this link due to the fact that the information is not always expressed on the same basis. For instance, it is common to find in the same label components in different languages. Furthermore, in some products, information is displayed in both words and symbols (e.g. sodium hypochlorite or NaClO). This kind of language with two different components –nomenclature and symbols– is specific to chemistry. However, it is necessary to know that, even though they are expressed in a different way –either one language or another, either nomenclature or symbol-, they do mean the same.

Table 3. *Information referred to the composition of the product*

Chemical compound	Example of some products
Anionic surfactants	
Non-ionic surfactants	Kitchen cleaners; detergents, bathroom cleaners
Cationic surfactants	
Amphoteric surfactants	
Phosphonates	Detergents
Polycarboxilates	
Sodium hypochlorite (NaClO)	Bleach; bathroom cleaners; glass cleaner
Sodium hydroxide (NaOH)	Ammonia; bathroom cleaners; Specific cleaning products for
Potassium hydroxide (KOH)	the kitchen
Quaternary ammonium salts	Cleaning detergents
Ethanol; isopropyl alcohol	Detergents; fresheners and fragrances

Attending to the way of expressing the composition, chemical symbols own specific characteristics as they represent a high level of meanings. For instance, NaClO

formula "is telling us" that three different atoms –sodium, chlorine and oxygen– form this compound. In addition, the proportion of these atoms is 1:1:1. However, Arasasingham, Taagepera, Potter & Lonjers (2004) show that only fifty per cent of the students give right explanations about the meaning of subscripts in chemical formulae. Besides, if individuals had the proper knowledge, they would know that NaClO is an ionic compound that has the specific properties of these kinds of substances: soluble in water or other similar solvents, conducts electricity in liquid state or in solution, etc.

One fact that attracted our attention was that there are several products that advert in their packaging or labelling that it is free from one specific component, but this ingredient does appear in the composition. For instance, we have found detergents that are advertised as alcohol-free, but in the composition labelling does appear "ethanol" or other component that ends in –ol (representative of alcoholic compounds). Similarly, we have found floor cleaners announced as "bleach-free", while they do have sodium hypochlorite; and hob cleaner "without detergent" but with surfactants within their components.

c) Information referred to procedures

Information showed in Table IV makes reference to procedures to be followed when using or storing the product. In this category, language is focused on instructions, which tends to be very simple and clear. However, they usually require the understanding of some conceptual contents, such as dilution, concentration or temperature.

Table 4. *Information referred to procedures*

Procedures	Examples of some products
Use a solution of 20 ml bleach to 5 litres of water	Bleach
50 ml per 10 Litres of water at 30ºC	Floor cleaner
Dilute first	Floor cleaner, bleach
Spry sparingly from a distance of about 20 cm away from the surface	Window and glass cleaner
Tip the bottle to fill de neck	WC cleaner
No need to rinse	Floor cleaner
Outstanding at low temperatures	Detergent
Pour at least a third (100ml) of the bottle down the plughole	Plughole unblocked bathroom
Store in a cool dry place	Washing up liquid
Do not store below 4ºC	Floor cleaner
Always reseal bottle and store upright	Floor cleaner, WC cleaner
Mop up spills immediately	Window and glass cleaner
On surfaces other than glass, mirror, tiles, test on an inconspicuous area first	Window and glass cleaner
Avoid use in aluminum/copper/brass	Floor cleaner
Not suitable for wool or silk	Bleach

In this section, guidelines are carefully given, indicating not only what to do (dilute first, for instance) but how to do it exactly (use a solution of 20 ml bleach to 5 litres of water, for example). Information is commonly displayed both textually, using words, and visually, using images represented by icons. According to this, Lemke (1998) indicates that in science, not only words are important but also the combination of other elements such as diagrams, images, tables, graphs, etc. However, these elements require different levels of understanding. For instance, tables and graphs (not very iconic but more symbolic) demand more training for the consumer in order to be interpreted. On the other hand, diagrams, photos and pictures, should require a lower level of training, due to their high iconic level. It could be considered

the more iconic character of the images, the lower level of education by the consumer. Therefore, since icons in labeling and packaging demand lower levels of understanding by consumer, they promote the comprehension of the instructions for use.

d) Information referred to security instructions

These contents refer to preventive measures, which indicate directly actions not to be done while using the product and measures to be taken in case of improper use of the product (Table V). The information presented here -legalised by CE No 1272/2008- is probably the most important content showed in the labelling. The misunderstanding of the instructions language may lead to a wrong follow-up of the protocol that can result in hazards such as intoxication or skin irritation, among others. Hence, the language of these contents must be understandable and easy to follow. However, there are some contents that are not clear and consequently, individuals may do not know how to act (e.g. "contains sodium hypochlorite and sodium hypochlorite solution").

Apart from these indications, there are also some pictograms with warning symbols which provide information about possible damages that a specific substance can cause on health or the environment. These pictograms have been recently modified and unified according to the CE No 1272/2008 and the CLP (Classification, Labelling and Packaging of substances). As commented before, the combination of these elements facilitates the comprehension of the security instructions. Similarly, the two types of images –iconic and symbolic- demand different levels of training by consumers, being higher for symbols compared to icons, that are much more realistic.

Table 5. *Information referred to security instructions*

Security instructions	Examples of some products
Always read the label and product information before use	WC cleaner
Refer to manufacture's washer instructions before use	Bleach
Keep out of the reach of children	Window and glass cleaner, WC cleaner
Do no ingest	All the products
People with sensitive or damaged skin should avoid prolonged contact with the product	Window and glass cleaner
Ventilate the room after use	Window and glass cleaner
Do not mix with bleach or any other household cleaners	WC cleaner
Contact with acids liberated toxic gas	Plughole unblocked bathroom
Wash hands after handling product	WC cleaner, detergent
May product allergic reaction	Floor cleaner
Causes serious eyes irritation	Floor cleaner, Spray cleaner
Always take care when using bleach on fabric	Bleach
Avoid breathing spray and point spay away from face	Window and glass cleaner
Do not breath spray	Window and glass cleaner
If swallowed, seek medical advice immediately and show this container or label	Plughole unblocked bathroom, WC cleaner
Contains sodium hypochlorite and sodium hypochlorite solution	Plughole unblocked bathroom
Causes severe skin burns and eye damage	Plughole unblocked bathroom
Do not breath fumes	Plughole unblocked bathroom
Wash skink thoroughly after handing	Plughole unblocked bathroom
If swallowed, seek medical advice immediately and show this container or label	WC cleaner, Window and glass cleaner
If product gets into eyes rinse thoroughly with water	Window and glass cleaner, WC cleaner

e) Information referred to environmental specifications

This group contains information related to the supposed environmental impact (Table 5). In this study we have just taken into account the information referred to the product itself, not to the packaging materials. Because of that, neither the terms nor the symbols about the extraction, fabrication or recycling process of the packaging are considered.

As can be observed in Table VI, most of these information are messages that suggest environmental benefits, but without substantiating argumentation. This practice -called "greenwash" or "greenwashing"- has been practiced by many companies in the last fifteen years, due to the fact that consumers have become more environmentally aware and companies take advantage of it (Delmas & Cuerel, 2011; Parguel, Benoit-Moreau & Russell, 2015).

Regarding to the household cleaning products, this practice is even more usual, as in these products the rate of "green" inventory growth is higher than in the overall products (101% versus 73%) (Terrachoice, 2010). The language used in this kind of messages includes words such as "eco-friendly", "environmental-friendly", "earth-friendly", etc., which are ambiguous and may confuse rather than clarify. The use of this type of language is defined as "sin of vagueness", which "*it is committed by every claim that is so poorly or broad that its real meaning is likely to be misunderstood by the consumer. All natural is an example. Arsenic, uranium, mercury and formaldehyde are all naturally occurring, and poisonous. All natural is not necessarily green"* (Terrachoice, 2010: 10). Producers and traders usually take advantage of the lack of knowledge of scientific language of a high number of target clients, by advertising their product through a fake image that improves the sales.

On the other hand, there are products that do show legitimate green certification, like the EU Ecolabel, which guarantees that products have complied with a set of criteria. This Ecolabel is an image which language facilitates the consumer identification of the products with this certification. Moreover, there are some messages with advises about how to save water, energy and CO_2. For instance, a specific diagram was created (commented in the information referred to security instructions category) in order to indicate that a substance is hazardous to the environment and causes aquatic toxicity.

Table 6. *Information referred to environmental specifications*

Environmental specifications	Examples of some products
Environmentally friendly	Plughole unblocked bathroom
Eco-chemistry	Detergent, WC cleaner
Environment safe	Detergent, dishwasher detergent
Use biocides safely	WC cleaner
Biodegradable	Bleach, detergent
Vegetal origin components	Detergent
Only vegetal origin surfactants	Detergent
No tested on animals	Detergent, bleach
It contains no phosphates	Dishwasher detergent, detergent
Non bio laundry powder contains among other ingredients	Detergent
Advices to save water, energy and CO_2	Detergent, WC product
EU Ecolabel	All the products

f) Information with advertising intention

This category groups all contents that highlight a property of the product with the aim of differentiate it from other similar. The analysis of this information might be a whole report, however in this study we have only taken into consideration some general aspects. This information is shown with bright colours and big fonts in order to draw the consumers'

attention. Another common strategy used in marketing is to show a strong scientific and technological component (Belova, Rundgren & Eilks, 2015).

However, not all these contents use science in a proper way. Concretely, there are several examples were science was used incorrectly in advertising (Campanario, Moya & Otero, 2001). It is quite common to identify messages with *apparently scientific concepts that do not exist* (e.g. [brand] oxiaction; ultraconcentrated; polar strength; oxiactive); *scientific concepts used in a wrong way* (e.g. power and pure; active power; biological active); *incorrect exaggerations* (e.g kills E-coly, salmonella, MRSA, rotavirus, flu virus (H1N1); kills all germs; effective against salmonella, E-coli, listeria and MRSA; provides complete hygiene for your toilet; kills fly virus); information with *incomplete quantitative comparison* (e.g. better reach = better cleaning; less powder, more power; 99,99% germ kill; removes 90% of allergens); e*rroneous and fallacious reasoning or arguments difficult to understand* (e.g. no enzymes or bleach; oxygenated additives; extra-bright polymers; very strong ammoniac; effective formula, natural power; more concentrated formula); and a*dvertisements that refer to science and technology as a source of authority* (e.g. recognising comfort, research into skin care. British skin foundation; dermatologically tested; stain lifting technology; new ultra power formula). This last practice is widespread and has been examined by several authors (Pitrelli, Manzoli & Montolli, 2006).

Another very common practice is the use of messages with negative connotations towards chemistry such as "the less chemical, the better" (Belova & Eilks, 2015). These authors remark the use of ‘natural’ in cosmetics advertising, which is extrapolated to other type of products including the household cleaning ones (e.g. less chemicals; contains pure orange oil; natural ingredients). Lastly, we have also found a wide amount of messages with an illegitimate use of the ecological and the green of the product (e.g. eco-chemistry; earth-friendly, etc). The use of this type of messages has been already discussed in the *Information referred to environmental specifications* category.

All these messages have an ambiguous, uncertain, indefinite and unclear language that may confuse individuals.

CONCLUSIONS

In the present work, the language used in the scientific contents of household cleaning products was analysed. Specifically, we detected simple words, symbols, formulas, pictograms, instructions with a more complete sentences, and advertising messages, some of them with lack of meaning. These facts evidence the great amount of science and technology references present in our everyday life, which highlights the necessity of providing a proper level of scientific literacy among individuals.

Since the purpose of language is communication, the message sent by the addresser should be understood by the addressee. In the particular case of producers and consumers of household cleaning product, this communication line can be impeded by several factors (labelling or packaging information removal, messages is foreign language, etc.), being language one of the main obstacles due to several reasons: (1) the meanings of the codes are not shared by addresser and addressee (do consumers understand chemical symbols?); (2) the message is not clear and concise (mistakes and exaggerations are widely used in advertising); (3) the addressee’s previous ideas may obstruct or distort the information carried in the message (“heat” and “high temperature”; “mass” and “weight”; “acidity” and sharp-tasting or sour). Thus, these facts suggest different scenarios.

1. Producers and traders should be aware of the communication gap resulted from the different use of codes between addresser and addressee. The use of the right language might reduce this gap by linking the knowledge required and the knowledge own by

consumers (by using units of convenience, or by more educational advertisings, for instance). This approach improves the mutual understanding where both parts benefit, consumers know what and why they are making a purchase and producers can show specific advantages of their product.

2. The use of unclear and no-concise messages triggers the spread of false conceptions of science, such as being incomprehensible. This situation is used by traders and producers to maintain an asymmetry in their relation with consumers. According to the Principal-Agent theory (Eisenhardt, 1989), the consumer (principal) contracts a service, and producers and traders (agent) perform this service. But the consumer needs the agent's opinion (or a prior consultation) and this "technical advice" defines an information asymmetry, since the agent has business interests in the aid provided. Thus, they are not always interested in the consumers knowing certain information about their product. Obviously, the individual would achieve the required level to defend their rights.
3. The addressee's ideas may obstruct or distort the information of the message. The scientific background of citizens is heterogeneous and complex which affects the decision-making process in their daily life. In this scenario, public institutions should promote guiding initiatives with the aim of science comprehension among the population. However, this implies a deep analysis of all scientific contents present in society.

In order to achieve a proper level of scientific literacy, individuals should follow three steps: being able to read, to understand and to interpret the information. However, this is not always easy because of the technical of the language. In this context and taking into account several studies, Brown & Ryoo (2008) distinguish between "vernacular language" –used in everyday contexts-, and "non-vernacular language" –more specialised, used in more specific contexts (Lavob, 1972). According to these authors, both vernacular and non-vernacular languages are used *"based on the speaker's understanding of the intended audience"* (p.530). Since individuals in general and students in particular need to understand information on the labelling of household cleaning products, the language used should sound familiar to them; therefore, a conversion between non-vernacular to vernacular language is required. Or expressed in other terms, individuals need to code-switch the scientific language to the daily life one (Moje, Collazo, Carillo & Marx, 2001; Brown & Spang, 2008). If consumers do not understand the meaning of the labels, communication fails.

On the other hand, and regarding to the formal educational point of view, each type of language analysed implicates different affordances in science, which have to be taken into account in the learning and teaching process (Akaygun & Jones, 2014). In this sense, one of the elements to achieve the scientific literacy is to understand the scientific language, up to the point that understanding scientific language is considered one of the main issues when learning science. The success of reading comprehension is determined by the understanding of vocabulary in general (Moghadam, Zainal & Ghaderpour, 2012) and the scientific vocabulary in particular (Seah, Clarke & Hart, 2011; 2014). In short, the familiar and unfamiliar vocabulary determines the comprehension of texts or speeches (Hu & Nation, 2000; Schmitt, 2000; Stahl, 2003; Bahçivan, 2014). However, teachers rarely take into account their role as communicators (Borsese, 1994), which might explain previous failures in achieving scientific literacy. This lack of awareness makes them underestimate the deep differences between daily life and scientific language, which is vital to the teaching-learning processes (Pozo, Sanz, Gómez Crespo & Limón, 1991; Galagovsky, Bonán & Adúriz Bravo, 1998). Accordingly, here we sketch out some ideas or recommendations of how to work scientific languages in the classroom without going into details, leaving the specifics to teachers.

One of the tasks of science teachers is to teach students to read and understand scientific texts (Fang, 2006). However, it is complicated for readers to unpack the encoded information in these texts due to their lexically dense writing (Fang, 2005; Glass & Oliveira, 2014). In this sense, labelling and packaging information has short sentences and do not present a lexically dense writing style. Moreover, they are familiar to students. Taking this into account, we believe that labelling and packaging information may be considered as another scientific text to work with in science class. In fact, Calvo (2014) has already used the scientific content of labels (all kind of products, not only household cleaning ones) to teach chemistry nomenclature.

According to the analysis of the scientific language of household cleaning products performed in the present work, we consider that students should achieve the following goals (among others) in order to acquire scientific literacy: identify the units and the magnitudes; be aware of the industrial procedures for the fabrication of a production and its effects on the environment; connect the characteristics of a specific product with his or her necessities and establish the advantages and disadvantages of a product; identify different types of ingredients and explore their characteristics (Ngai, Sevian & Talanquer, 2014), recognize chemical compounds and encourage learning chemistry nomenclature, etc. Taking into account this last aspect, science and chemistry teachers should be aware of the difficulties and problems with the meaning of symbols (Marais & Jordaan, 2000). Thus, these authors suggest some recommendations of how to work these contents in class.

For that, activities should be oriented to solve theoretical questions (e.g. change of units, calculations of percentages and amount of substance); to carry out estimations (e.g. how many taps does this packet of detergent content?) and investigations (e.g. where do the products waste goes?); to develop scientific testing (e.g. what is the pH of this detergent) and critical thinking (Carvalho et. al, 2015). In addition, students' attitudes towards the effects of human activities on environment, modern purchasing and advertising, should also be worked through activities that evidences the necessity to analyse correctly situations using empirical data and avoiding personal opinions or public belief. Anyhow, these are only some ideas and orientations. Details and final execution will depend on each teacher.

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