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Popularisation of science on the Internet as exemplified by Facebook

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Abstract

Nowadays the use of the Internet enables anyone to access a huge amount of information on any topic. However, when scientific contexts are approached, it often becomes difficult for the 'generic' user to understand the research results. Internet, the network of networks, has become the symbol of global society. The net, understood both as a technology infrastructure and as a global social community, is the space where information, data, knowledge, and skills are increasingly created and disseminated. This article considers a particular area of net communication, that is related to science; it comes from academia and through the popularization of results, reaches the public. The current situation of science on the web is analysed, focusing also on the obtainable scientific information on Facebook through pictures.

Key words: science, physics, popularisation, internet, net, Facebook, culture, education.

Introduction

Science popularisation is a universal activity ; it helps to spread scientific culture, increases the perception of the importance of science and strengthens its roots in society. This form of communication must offer contents in a non-technical language, inserted into a broad framework that allows all types of users to understand the subject matter. In recent years, methods of communication have multiplied, with a double effect: on one hand, it facilitates access to what happens in the world; on the other, everyone can become a potential source of new information.

Through social networks the involved people share what they experience personally, fueling a new form of journalism that we could call "collaborative journalism"; it may be relevant to chronicle events and science popularisation (*Scientific research in the media*, 2007).

The non-disclosure of research heightens the gap within society and promotes the spread of bad scientific information by media. In addition, researchers often participate in communication activities mainly with companies and administrations, and secondly with students and people. The lack of communication skills of research institutions is in opposition to the desire of knowledge by people, who increasingly use the web to satisfy their curiosity or needs.

Among the most visited Internet pages, there is Wikipedia (*Wikipedia*, 2017); a free collaborative encyclopedia, available to everyone and to which anyone can add information. The online scientific information is available in different ways; in particular we remember the scientific “peer reviewed journals,” the “popular science sites,” the “blogs.”

a) The peer reviewed journals publish results of scientific studies, reviewed by experts of the same field; they verify whether the work can be published as it is, or needs modifications. Articles are written almost exclusively in English with a specific language of the treated discipline; for this reason the recipients are almost entirely specialist users. This fact does not facilitate general consultation.
b) The reliable popularisation sites spread to a general audience scientific articles published in peer reviewed journals, framing the problem within the discipline, indicating the sources, using different languages and avoiding mathematical and linguistic technicalities.
c) The term “blog” is a contraction of “web-log,” i.e. “diary on the net.” A blog is managed by one or more people, the “bloggers,” who generally utilize an accessible language for non-experts, being able to reach a large number of users. One of the biggest limitations of blogs is the not always high competence of bloggers about the topics. The presented contents are not necessarily reviewed and the sources are often not mentioned; this may create misinformation.

In the survey of Internet sites that deal with popular science, universities are almost entirely lacking, i.e. the institutions where most of the national scientific research is carried out. This happens mainly because popular science activities are not relevant for the academic career.

Scientific revolution and the Internet

The scientific and technological revolution is producing extraordinary transformations in the lives of everyone. Among the many ways through which this phenomenon is occurring in every area of human activity, the Internet, the network of networks, has become the symbol of global society. The Internet represents the possibility to realize the idea, sketched in the encyclopaedists of the Enlightenment era, to offer to each person the knowledge at any time and in any place. These aspirations are also materializing in policies of promotion of science and technology.

The internet is part of the scientific revolution and has developed a different logic with respect to that of the industrial revolution. The development of science and technology is enabling:

- extension of interdependence among people;
- realisation of the creative abilities of people;
- bringing together the production processes and those related to the transfer of information with the educational ones.

The revolution of information technology is enabling the inter-operability of nets; the Internet is the most mature expression of this trend, through the radical change in the way people store and spread knowledge. In a few years the volume of traffic on the Internet has equaled that reached by the telephone network in over a hundred years, becoming an important increasing factor of communications and inner and international trade for the states.

Statistics tell us that the Internet is today the premier source for news and scientific information; in second place there is television (*Pewinternet*, 2017; *Exploratorium*, 2017). Users search scientific information on a website for many reasons:

- for finding the meaning of a scientific concept;
- for answering a specific scientific question;
- for learning details about a scientific innovation;
- for finding help for school projects;
- for checking the accuracy of a scientific fact;
- for comparing different scientific theories (Di Sia, 2016).

Even when the need relates to retrieving information about specific topics, people say they turn to the search engines in 90% of cases, also when users know online references.

Scientific research is the methodology used to raise knowledge, one of the key factors for growth and development of society in the medium-long term, because it provides innovation and progress. The new knowledge determines a better lifestyle for society; the scientific and technical progress should be the foundation of every culture and modern country.

Communication systems and evaluation of knowledge

The characteristic elements of the traditional communication systems in the scientific field, which remained mostly unchanged until about 1970, were defined in Europe, particularly in England, in the late seventeenth century and the first decades of the next century. Thanks particularly to the dissemination of press at the precise historical, cultural and political context, the process reached a definite and almost final form. At the Royal Society of London the first scientific journal was born; the practices of scientific accreditation, still in force, have been outlined. In particular we remember the "peer reviewing" process, the concept of "copyright" and of "author" as the subject of rights (Dooley, & Baron, 2001). The system of traditional scientific communication has been recently disrupted by the advent of the Internet and the Web.

The trading patterns of knowledge are many and include, in general, different functions. John Willinsky identified three main purposes:

a) the development of innovative knowledge;
b) the evaluation of the quality and the discrimination between good knowledge and false and irrelevant knowledge;
c) the dissemination and the actual effectiveness of the proposed knowledge to the public (Willinsky, 2000).

Other models based on five key moments have been proposed:

a) the "registration," which allows the exercise of priority rights on a scientific discovery;
b) the "certification," which establishes the validity of a discovery, once registered;
c) the "realisation," which allows players of the scientific system to become aware of new titles and discoveries;
d) the "storage," which ensures the recording time;
e) the "reward," which rewards players for their performance in the communication system, on the basis of metrics that derive from the same system (Van de Sompel *et al*., 2004; Whitworth, & Friedman, 2009).

At the center of each of them, publications are located in the form of articles in periodicals or monographs. The publication of scientific results has become over the centuries a cornerstone of scientific communication, in which journals have taken a leading role.

Always, publications are linked to the problem of the evaluation, a key moment that interests the public (in terms of relapse in public investment, lines of development and sustainability of research), capital providers and public and private investors, universities, research centers and individual researchers (as key factor for accessing the academy and for having a career). This evaluation method is widely used, even if there are lights and shadows on it (Di Sia, 2015). The traditional system of publication in the scientific field has been defined as "feudal" because it is exclusive, dated (not updated), conservative (as resistant to change and innovation), and whose contents are often inaccessible to people because of being too specialist (Björneborn, & Ingwersen, 2004). The advent of the Internet and the Web is changing the situation, replacing the so-called webometric indices to the bibliometric ones; they compute citations on online databases. The webometric analysis was born on the way of bibliometrics, for measuring the scientific production which is disseminated through the Web (*Introduction to Webometrics*, 2017).

Sharing Science on the Internet

Scientific research has been completely transformed by the availability of the network, namely the large net woven by Internet and the web around the world. Normally people starting a new project do not make any of the acts that until a few years ago were the norm for these kinds of activities, i.e. to go to the library, consult books, scroll journals, examine dozens of hand-filled cards. They go directly into the net, in which they can get documents, articles, data, results from other experiments, news about the activities of other laboratories of interest (Naughton, 2000). The Internet, designed as a tool for sharing information and computing resources, has revolutionized the activity of research, turning the principles of collaboration among scientists and of the free spread of scientific knowledge into a work practise, and enriching it over time with new tools. The movement for open access to scientific literature was born in the academic community by launching a campaign in favour of sharing information and knowledge, understood as common property. It is also intended as a solution to the problem that plagues the world of libraries and known as "crisis of the journal pricing," i.e. the dramatic increase in the cost of subscriptions to scientific journals.

On Facebook, the most popular social network, there are pages that tell about science in a simple and interesting way, making the latest findings accessible to millions of people. Most potential readers are anyway inside the confines of the network; the wish to write goes hand in hand with the conversation that a written opinion generates, with the debate that it is able to create. These debates, often generated by a content hosted on a blog, are increasingly moving today from blogs to social networks, sometimes in a fragmentary and inorganic way, although not necessarily superficial and inadequate. The first reactions arrive just on social networks, before and faster than the comments on blogs. We are witnessing a transformation of blogs that give way to social networks. In international research projects, a website of dissemination of results more and more frequently is included, as a Twitter account, a Facebook page.

Although much of the science popularisation made in the network with blogs or other means, in fact speaks to "already interested ears," it is increasingly common and it is hoped that these contents also reach those who do not search directly this kind of information.

Scientific popularization on Facebook through pictures

In this section, we consider some pictures recovered from Facebook and open to free use, which appropriately present important scientific information, in particular in relation to physics. Normally these pictures are on dedicated pages on Facebook, with a moderator, and also checked by followers, to avoid the dissemination of wrong concepts and news.

Figure 1 shows one of the main features of the atomic structure, i.e. the composition of atoms almost entirely of empty space; it is explained how the size of reality would change considering only the matter that constitutes the atom.

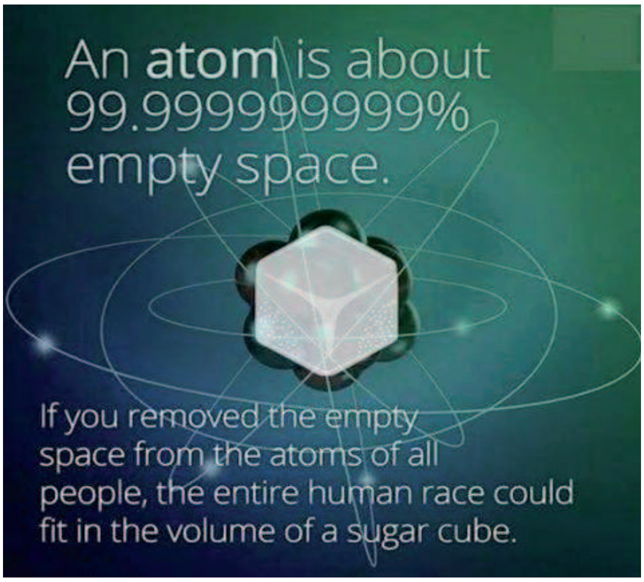

Fig. 1. The composition of the matter. *Source: Retrieved March 13, 2017, from https://www.facebook.com/.*

In Figure 2 one of the strangest features of quantum physics is indicated, i.e. the problem of the reality of the essential tools with which it has been created. One of them is the concept of "wavefunction," which is still subject of scientific and philosophycal debate about its 'reality'. We have a "perhaps not real" object of the microscopic world, which in fact very well describes the "known reality". It also emphasises the "shocking" aspect of quantum physics that, despite its still unclear aspects, provides a very accurate description of reality. The words are of Niels Henrik David Bohr, theoretical physicist, mathematician, philosopher of science; he made fundamental contributions in the understanding of atomic structure and quantum mechanics, for which he received the Nobel Prize for physics in 1922.

Figure 3 is an example of how it is possible to condense in a picture much information about a scientific theme. In this case we talk about Cecilia Payne, Anglo-American astrophysicist, noted for her contributions in understanding the composition of stellar masses. In her doctoral dissertation she has indicated the elements that make up the material universe, with hydrogen as the most abundant element. Her thesis was considered 'impossible' by contemporary experts, which were then proven wrong by subsequent scientific findings. The figure also adequately points out the patriarchal structure of academic institutions of that time.

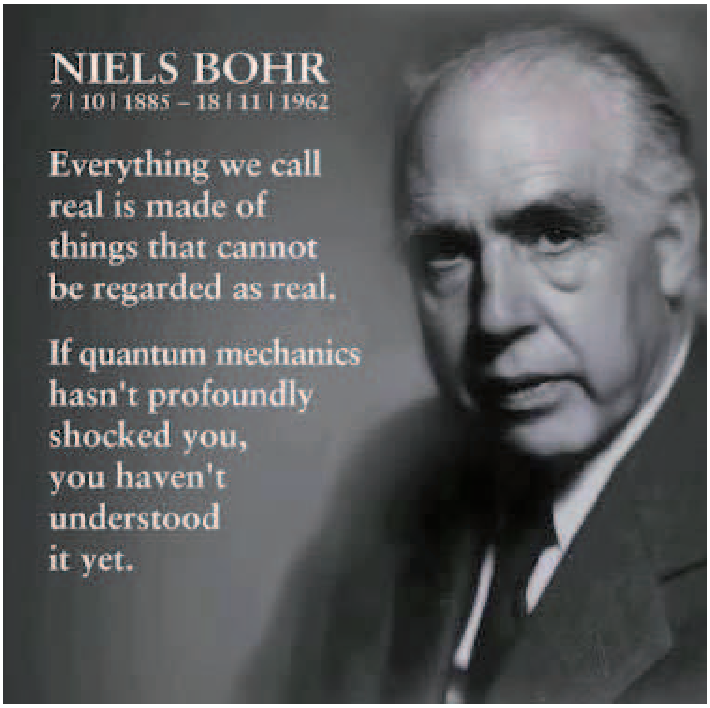

Fig.2. Bohr and quantum mechanics.
Source: Retrieved March 13, 2017, from https://www.facebook.com/.

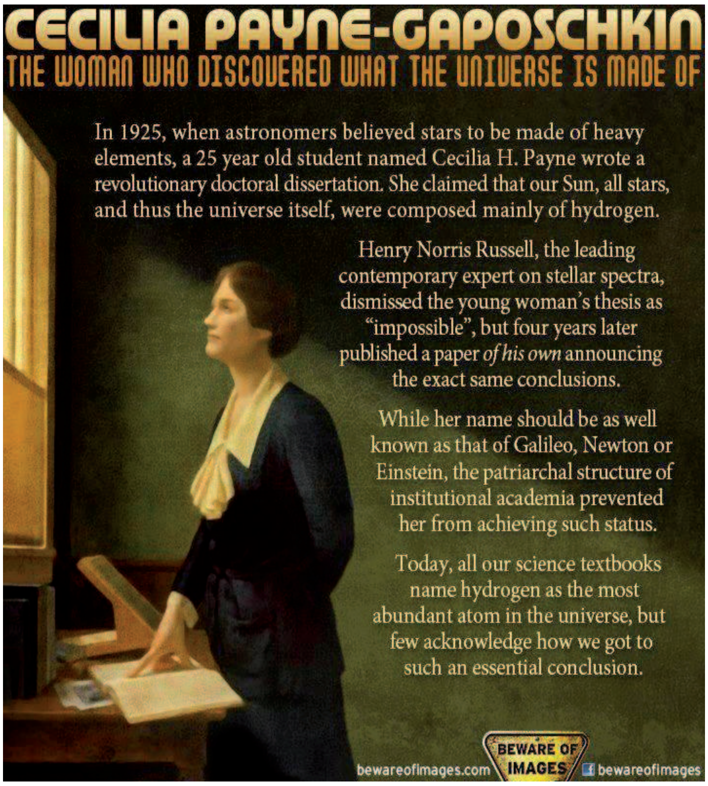

Fig. 3. Cecilia Payne and her discoveries.
Source: Retrieved March 13, 2017, from https://www.facebook.com/.

Figure 4 indicates a sentence of one of the fathers of quantum physics, Werner Heisenberg, German physicist, one of the founders of quantum mechanics, Nobel Prize for physics in 1932. He emphasizes the relationship between science (physics in particular) and theosophy, and how the two disciplines, kept apart for many centuries and even considered self-excluding, can on the contrary grow side by side, without negative superpositions.

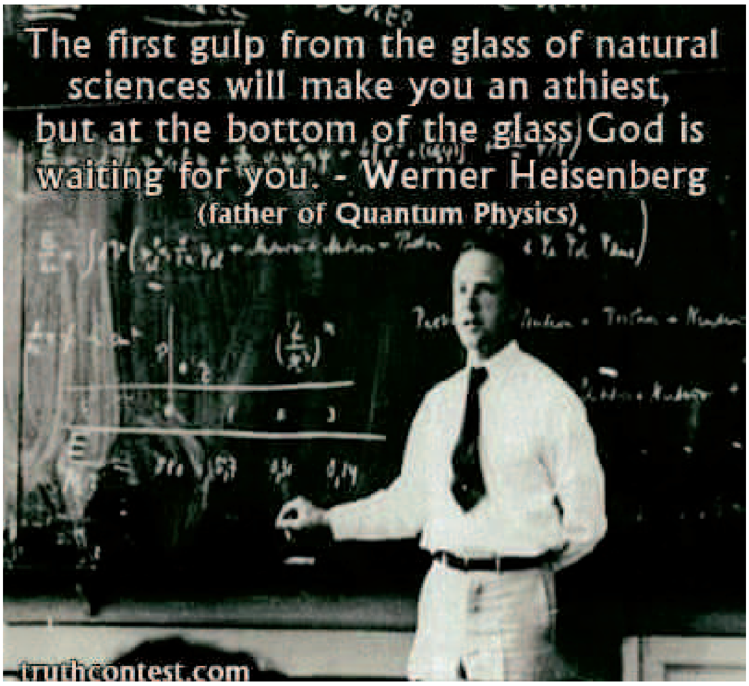

Fig. 4. Werner Heisenberg and the relation "science-theosophy."
Source: Retrieved March 13, 2017, from https://www.facebook.com/.

Figure 5 provides 'quick' quantitative technical information, giving an assessment of the potential of the human brain. This information can be useful also for both calculation in close scientific topics and for everyday life.

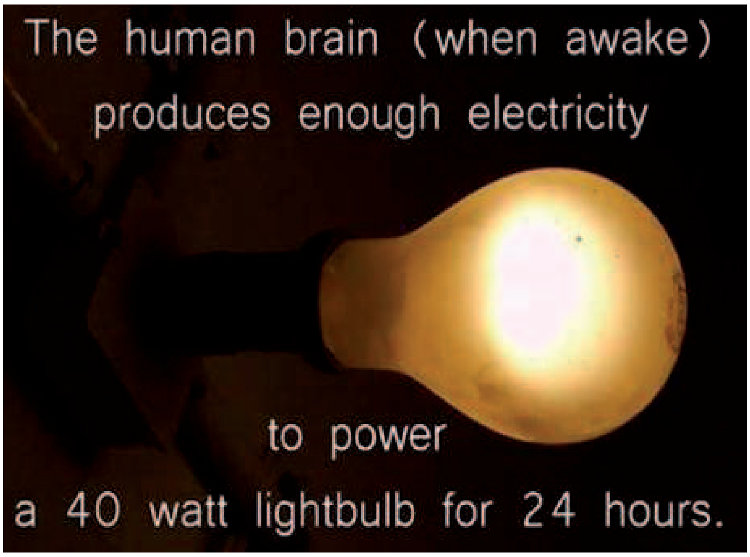

Fig. 5. The power of human brain in numbers.
Source: Retrieved March 13, 2017, from https://www.facebook.com/.

Figure 6 talks about the evolution of the meaning of gravity in relation to mass and space. The Newtonian concept of "mass," linked to that of strength in a space considered "absolute" and not dependent on it, has been extended by Einstein into the concept of "mass-energy." So the concept of Newtonian "space," independent of mass, is reviewed by Einstein as "space-time," deformable by the presence of the mass, which creates a gravitational field. The figure well summarizes the three key concepts: "mass," "force," "movement." Newton and Einstein are two pillars of physics of all time.

Figure 7 deals with another of the "disconcerting" characteristics of quantum physics, i.e. the "wave-particle duality." From quantum mechanics derives the concept that "particles" have associated a "wave," i.e. they can be described both as particles and as waves. It has been experimentally shown that in some experiments they behave like particles (matter behaviour), in other experimets like waves (wave behaviour). Sir Joseph John Thomson, Nobel Prize for physics in 1906, was a British physicist and engineer, known especially for his discovery of the electron in 1897. George Thomson, British physicist, son of Joseph John Thomson, received the Nobel Prize for physics in 1906 for the proof of wave-particle duality, simultaneously and independently performed also by physicist Clinton Davisson, with whom he shared the Nobel Prize.

Figure 8 makes an interesting association between each element of the periodic table of

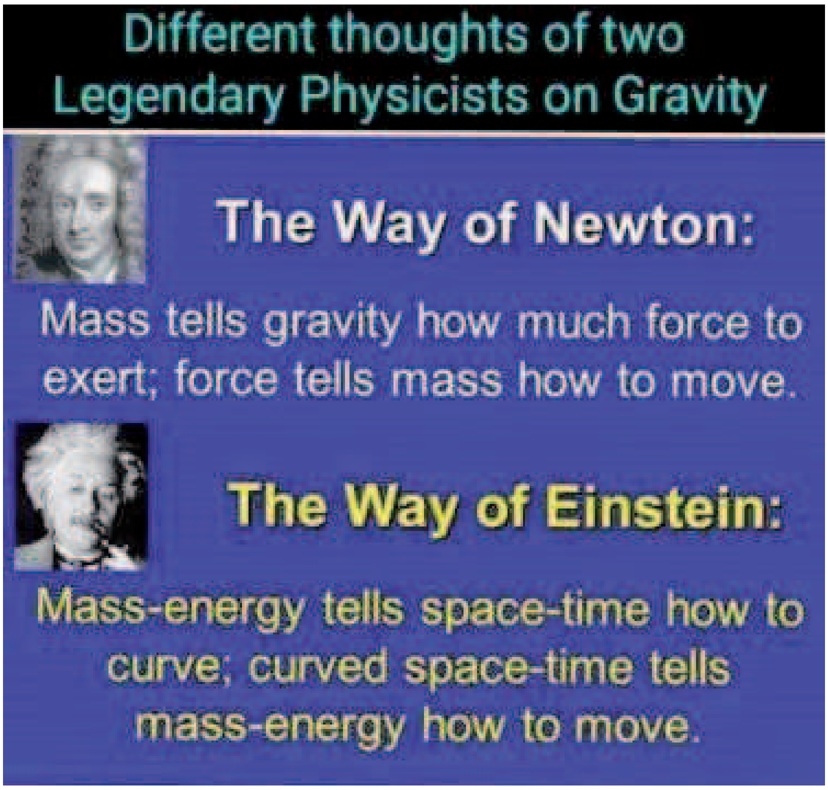

Fig. 6. Newton and Einstein about gravity.
Source: Retrieved March 13, 2017, from https://www.facebook.com/.

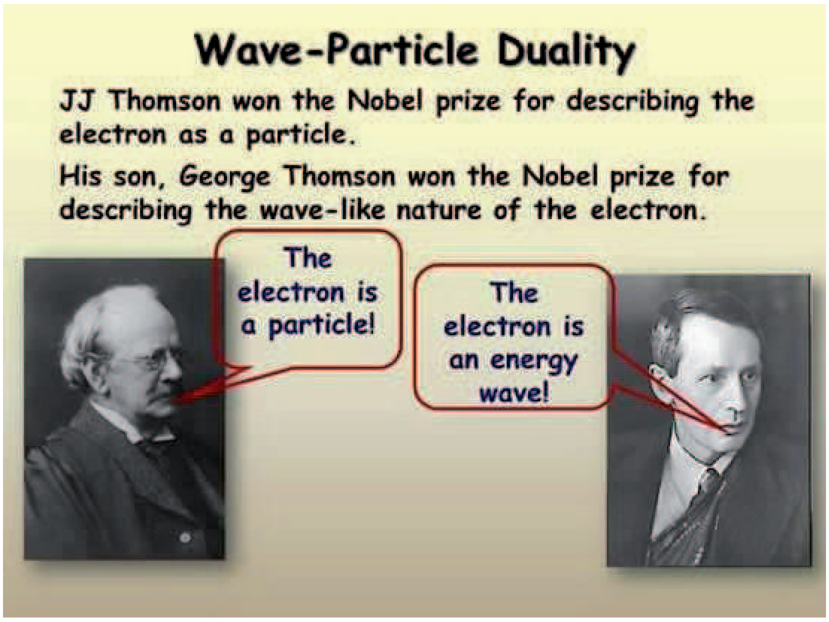

Fig. 7. Thomson father and son about the nature of the electron.
Source: Retrieved March 13, 2017, from https://www.facebook.com/.

Mendeleev, the particular cosmic structure (cosmic rays, various types of stars) in which we find them, the time evolution of the universe (Big Bang, past time, present time) and the man-made elements. The picture well summarizes all these features.

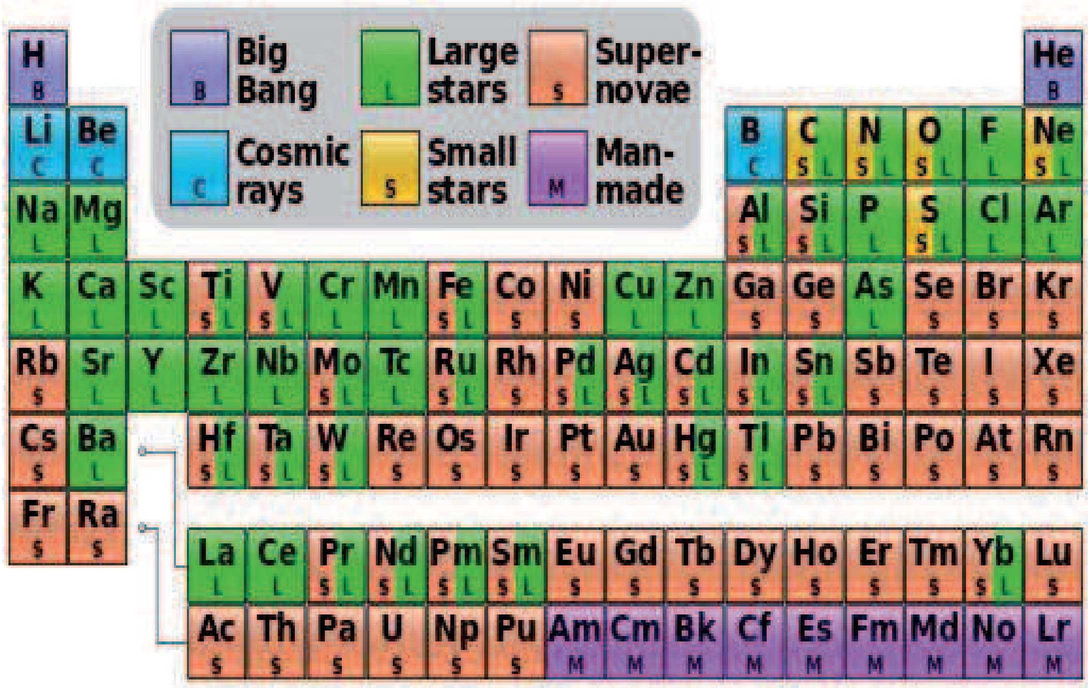

Fig. 8. Where do we find the Mendeleev elements in the universe?
Source: Retrieved March 13, 2017, from https://www.facebook.com/.

Conclusions

It is important to talk about tools, but even more about science communication on the net, whether it is a blog, a newsletter, a podcast, an intelligent presence on social networks. The network has taken on its own dynamics, which also affect how we talk about science and the way in which communication can be little or very effective if done with these specific means.

Many scientific contents, located on the net, are object of attention mainly by people who have the topic at heart; however, it is increasingly common that this information reaches people who are not actively looking for content related to science, not leaving them indifferent and generating curiosity and attention, which are positive for the global dissemination of science and culture. It is therefore desirable to increase this scientific presence on Facebook, which offers interesting information, attracts the attention of people and can be a starting point for further study on the involved issues. These pictures can be an interesting starting point for further insights and correlations also for students and children.

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