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Science Communication and Science-People Relationships

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Abstract

There are two crucial types of communication in science and technology: interaction between scientists and communication between them and the public. Scientists enjoy the spoken and written communication between themselves in a symbolic language that is largely incomprehensible to others. Throughout history, they have maintained contact with one another via the books they have written and read. The transition from handwritten to printed books contributed greatly to the development of science and culture. Correspondence and salons helped them to share information and unite the efforts of people of both science and art. The journals that emerged in the mid-17th century gradually became forums for scientists. The work of scientific journals then covered an unimaginably broad scope.

Communication between scientists and people, the transmission of scientific innovations in language understandable by the layman, that is, in "everyday language", is very significant in itself, for the organizations they work in, for the governments that implement policies to develop science and technology and, also, for their readers and other shareholders. Informing people about scientific innovation is a crucial aspect of public relations. Newspapers, magazines, radio, television, the internet, the mobile devices in everyone's hands, exhibitions and face-to-face meetings have all fostered direct contact between scientists and the people. The hauliers along the road from science and technology to the people include popular scientific literature and the remarkable works written about the history of science.

Keywords: science communication, public relations, book, letter, salons, journals, popularization of science

Introduction

Science and technology are the driving forces of history and the country, as well as indicators of a society's level of development. The holders of this huge and prominent power inform one another, communicate and unite their efforts to

increase this power. How does this happen? On the other hand, it is imperative to keep shareholders and even wider society, informed about the core successes and also the challenges of science and technology. How is this resolved? This paper will discuss the ways and peculiarities of spreading scientific-technological novelty among scientists themselves, as well as reaching out to the public in accessible language. This article is based on a speech given to an international conference in Tehran (6th Science and Technology Exchange Program, Tehran, Islamic Republic of Iran, 9 November 2019).

The participant, listener, viewer, reader, in general, the audience for pure scientific-technological communication, that is to say, for interaction among scientists and engineers, is the scientific-technological community – the experts. Such discussions are not in the "language of the 'person in the street'", it takes place in a particular symbolic language not accessible by others, it concerns a specific field of science or high tech and is a "foreign language" full of strange terminology. However, the wide diffusion of scientific-technological innovations is a unique process of communication within society, with the people; it is a significant part of public relations and is to convey the novelties of science and technology to the public in "popular language", the target audience for this information is the vast mass of the population, the people.

Scientific communication. Book and Letter

The development of science is impossible without communication. Without knowing who achieved what and by which methods, it is not possible to take a new step. From ancient times to the present, communication and correspondence have been essential, and a variety of methods have been used to disseminate and deliver information to the different people and places considered to be important. The desire of the author has played an important role in transmitting knowledge acquired; it is the author who informs about his/her successes, expresses him/herself, craves comments, praise and applause from those who understand the field and, consequently, is satisfied, enjoying those happy moments.

Probably, the greatest and the most significant of humanity's inventions – writing – became the world's changemaker. It enabled the sending of thoughts to destinations near and far, as well as to future generations. Correspondence was realized by letter. Political, ideological and religious texts, fiction and scientific thought, were publicized in the form of books. To publish those books, in different regions and periods, particular materials were used: books in cuneiform writing on clay tablets, books on rolls of papyrus, prepared from the plant of the same name,

or books written on parchment – specially tanned animal skin – and, finally, books made with a Chinese invention – paper. For every new copy of a manuscript written by the author, the whole book had to be copied by hand, hard work indeed. Johannes Gutenburg's mid-15th century initiation of publishing by movable print became one of the principal forces driving European development. It became possible to print hundreds, thousands of copies of books in a short period; the price of books fell and it became easier to buy and read them. The publishing of books reduced people's dependency on the church and monarchs.

Letters were essential to the development of science. In this way, researchers could discuss issues of mutual interest, ask each other questions and receive the answers by sending letters across long distances. Hence, they could also maintain confidentiality (in case they did not want to make their ideas known). Correspondence between Biruni and Ibn Sina was dedicated to discussions about very curious matters. Biruni asked, İbn Sina answered and, from time to time, Biruni argued. The letter-debates between Fakhruddin Razi (1149-1209) and Ibn Al-Arabi (1165-1240), and those between Nasiraddin Tusi and Sadr al-Din al-Qunawi are quite compelling too. Correspondence was widespread among intellectuals in the Europe of the 17^{th}-18^{th} centuries (and partially the 15^{th}-16^{th} centuries) when science and the arts were reviving, and great discoveries were made. Without a doubt, the well-developed postal systems stimulated this.

As a free-thinking international community was established, its members or citizens were writers or thinkers. It was called the Republic of Letters (or by its Latin name - *Respublica litteraria*). Among the outstanding members of the Respublica, Fabri de Peiresc (1580-1637), Marin Mersenne (1588-1648), Ismaël Bullialdus/Boulliau (1605-1694), Henry Oldenburg (1619-1677) and Henry Justel (1619-1693) are worthy of exclusive mention for their unceasing correspondence and maintaining communications with the prominent scientific, literary and other intellectuals of the age. Voltaire (1694-1778) wrote some 23,000 letters to hundreds of people. Alexander Humboldt (1769-1859), the outstanding naturalist, geographer, and traveller, sent approximately 50,000 letters and received 100,000. George Bernard Shaw (1856-1950) and Isaac Asimov (1920-1992) are among those at the top of the list for most letters written. Shaw supposedly wrote more than 250,000 letters (only about 10% remain). Asimov wrote some 90,000 letters. And now, created with the help of the internet, websites, Facebook and blogs are the World Letters Republic of the latest era.

Salons

In corresponding with each other, peers of science and arts were essential to the start-ups of academies and scientific-literary societies. And of course, citizens of the Republic of Letters, craving face-to-face meetings, rushed to the salons. There they established social relationships, made new acquaintances, and initiated creativity and research plans. Broadly, these salons were open and gave rise to real opportunities, though nobility and playfulness were indeed also apparent. Of course, the salons of London and Paris were charming. Women had crucial roles to play there and generally led the salons. The coffee houses that spread through Europe, influenced by those in the Ottoman Empire, became places for politicians and scientists to meet and discuss their political and scientific ideas.

Journals

The second half of the 17th century, saw the rise of journal publishing. The first was published in France in 1665, January 5th. Entitled "*Journal des sçavans*", it mainly comprised book summaries, specific information and non-scientific texts. The revolution closed the journal down in 1792, but it revived in 1797 for a short time. Only in 1816 was regular publication resumed, as "*Journal des savants*" by the Institute de France, when it adopted a literary course. The journal "*Philosophical Transactions of the Royal Society*", which launched on March 6th, 1665, in London, became the first and, for a while, the only major scientific publication. It entered history also as the first scientific journal to put articles through a peer-review process. Following these, during the 1660s-1670s new journals on the humanities and medical sciences came to light. At the end of the 17th century, journal publishing saw the light in Germany, Italy and other countries. Approximately 30 journals in the 1770s, at least a thousand by 1790 and, by the 1860s, around 1400 scientific and technological journals were being published (Lightman, 2016).

The journal did not cause correspondence to disappear for a long time. The publication of newspapers that spread across Europe in the 17th century covered topics like scandalous news that created uproar, some economic news, propaganda information, and later shed light on wars being fought, but they paid almost no attention to scientific matters.

Even though specialized journal publishing (chemistry, botany, physics, mathematics, natural history, medicine, philosophy etc.) began at the end of the 18th century and gave special voice to people of science, there were hardships too.

Many journals of narrow interest were closed; they could not survive due to lack of authors and readers (sellers and buyers), or they merged with others to represent broader fields, taking new titles and broader areas of activity. On the one hand new science and arts academies, associations and societies were founded, and they published their journals (as official bodies), on the other hand, journals or scholarly publications (mostly with commercial purposes) emerged upon some personal initiative and were not connected with those entities. The practice of journal publication was improving, along with the development of publishing businesses in Europe (e.g. Taylor & Francis in London, later, Springer, Elsevier, …).

The value of correspondence declined while publishing articles was becoming the central outlet for scientists. Scientific journals boosted the rate of publishing by scholars and inventors. The necessity of writing books faded as scientific innovations were publicized in written articles. In the 19th century, popular science journals and illustrated publications were also widespread, so the means of communication between scientists and public increased.

In the 1950s, the number of journals approximated 100,000. Currently, many more than one million journals are published. Nevertheless, the influential Web of Science journals linked to Thomson Reuters (now Clarivate Analytics) add up to around 12,000, and another crucial periodic scientific publication body - Elsevier's Scopus journals - total some 23,000 (many journals are included in both sources). There were about 33,100 active, scholarly, peer-reviewed English-language journals in 2018, which collectively published about three million articles in the year. Journals included in Clarivate Analytics (2018) together published about 2.2 million articles, reviews and other source items annually. Elsevier's Scopus journals contain over 69 million core records, with approximately three million new items added each year (Johnson, et al., 2018).

The passion for writing as many academic papers as possible is gradually growing, to achieve recognition, to gain status in the workplace/organization, and to win grants. Scientific activity is, of course, both useful and very desirable. However, increasing the number of articles cannot but be creating a certain artificiality. Even while Einstein did not see the quantitative competition of recent decades, he sensed his era's malady for writing numerous articles; 'An academic career in which a person is forced to produce scientific writings in great amounts creates a danger of intellectual superficiality' (Isaacson, 2007, p. 79). Another distress is mass character and a relaxing of quality control as the result of haste. Given that the number of journals claiming principles of anonymous review is increasing, the issue of quality becomes complex; it is difficult to find the experts to meticulously read the abundance of research papers and write reviews.

Unfortunately, the commercialization of scholarly articles has created a massive hindrance to an open access policy and the transparency of science; it has also weakened quality control.

Science and Technology News for the Public

Professional journalists have some exciting ideas about how to highlight and interpret scientific issues in the modern media. But what do scientists think about that? It is almost impossible to communicate scientific and technological innovations to the public without the participation of specialists from the theoretical and applied sciences.

Public relations is the work of disseminating news, delivering it to the public; it is communication with the people. PR is for creating an image of the subject in the eyes of the public, forming public opinion, and establishing ties with them. Depending on the purpose and the skills of the person who sets out to create the impression, poor, real or exaggerated imagery may be used. The latter is commonly applicable to advertising.

The aims and methods of the two styles of communication, communication between scientists and informing the public about the sciences, are varied. People of science and technologists disseminate their ideas and scientific results in scientific journals and conferences, and/or through presentations and exhibitions; they want their colleagues to be informed, at the same time, they are willing to read, see, and study the work of others. However, PR about science and technology or innovations is directed towards promoting the reputations of those scientists and technologists, and of the universities or research centres they work for; it tries to explain the news in "popular language" to stakeholders, governments or potential enterprises, that may be sources of funding. The PR of science and technology utilizes newspapers, magazines, radio, television, the internet, exhibitions and face-to-face meetings as its means of communication.

Good quality, professional and clear PR of science and technology increases respect for, and interest in, science; nevertheless, oversimplification and embellishment of science and technology, without precise understanding of the essence, creates distortion. Shoddy and incorrect PR damages the reputation of the scientist and of scientific and technological organizations.

Most journalists do not understand science or technology, or they enjoy just a small amount of imagination and knowledge, not enough to allow them to reason

properly. Consequently, the likelihood of contradictory arguments in their articles is no small matter. Headlines or commentary written by journalists to create sensation or intrigue confuse people or pass on false impressions to the readers, viewers or listeners. Another factor is that many journalists have backgrounds in the humanities or arts (Goldacre, 2008). If journalists consulted people of science before writing their reports or articles or had them read their final drafts, they would avoid many of the misunderstandings.

In political, economic and scientific gatherings and conferences, in articles, books and other media we frequently come across expressions like: 'We are in the age of a knowledge economy'. The politicians and bureaucrats employing this language do not always aspire to support investment in research and development (R&D). But here, the clear and convincing transmission of information about science and technology to the public can help to attract political and financial support, which is vital for their advancement. A developed country is one that has achieved such advance; even economic development is itself mainly connected with science and technology.

The rapid progress of the internet, the mobile devices that everyone carries, video sharing websites, Facebook, ResearchGate etc. have encouraged direct contact between scientists and public. The leading traditional print and broadcast media are also connected to the internet. Television, mobile phones and YouTube have a special role in visual popularizing science and technology.

However, the direct communication and understanding between scientists and the public are fragile. The ordinary person's imaginings about modern science, if she/he has any, are scanty. The scientist believes that people live with momentary feelings and do not understand or appreciate the sciences; and people who are remote from science and critical of it, in their turn think that scientists do not deal with society's problems, but are mainly involved in theories that are abstract and removed from reality. The responsibility for informing people who are interested in science but not expert in it, rests with the scientists themselves, and with journalists who report on scientific and technological innovations; they are the ones to pass on information about the global challenges ahead and the role of science in their solution, and they must do this in accessible language.

The History and Popularization of Science

The popularization of science is crucial to the formation of a people's world view, to enhancing their appreciation of science, to sowing or boosting interest in science

among adolescents and youth. Popular scientific literature is of prime importance in the making of future scientists or causing scholars to bend towards wider scope rather than limited specialization. Indeed, scientists are the most active readers of popular scientific literature! And of course, the most attractive popular books on science are written by prominent scientists.

It is better that popularization be a responsibility of scholars. It has been revealed that during the years 2005-2007 one-third of the scientists in 13 countries wrote popular scientific articles (Bauer, et al., 2011).

It requires upbringing, environment and taste to read materials written in the languages that we speak or know, to feel their beauty and harmony, to observe, or listen, and enjoy. Admittedly, it is a privilege to have been educated in a subject, compared with someone who has not had that privilege… Science, unlike music, the arts and literature, for example, is a matter primarily of the mind, not the feelings; a few members of society create it and few comprehend it. We can talk about the weakness of the mind (Pascal, Kant, …) as well as its strength (Einstein, …). There is little demand to delve into theory or obtain specific professional knowledge in order to love literature, fine arts and music, in fact, to put it carefully, there is almost no need to do so.

Science is a complex area of activity; it has a specific language and it is hard to apprehend. The ability to popularize complex scientific theories by using simple language depends, in my view, on at least three factors: how clearly and profoundly the author knows every nook and cranny of his/her subject, his/her writing and teaching skills, and the time dedicated to this work. Regrettably, most people of science are not able to convey their science to the public in popular language and in an interesting way.

In an era when science is very much diversified, divided into diverse areas, with narrow specialization on the increase, a single person cannot understand the whole treasury of knowledge and expertise, even if that person is a genius. This is so true that even one scientist learning the entirety of one discipline (mathematics or physics, chemistry or biology) and conducting a full range of activities within that discipline, is inconceivable. Now, acquiring theories, ideas and methods from other areas, which may seem either relevant or distant, helps to obtain new, unexpected results in science. But can a person adapt different fields of science without being a specialist in them? The solution is, at least to start with, guidebooks written in clear language and encompassing much of the knowledge, the history of development, and the main ideas embracing the discipline.

From my standpoint, one way of fostering scientific communication and demonstrating the curious and significant aspects of science, is to write books on the history of science and teach courses on the history of science at different levels of education.

Popular books about astronomy generally arouse more interest than other subjects. Indeed, compared with mathematics and theoretical physics, talks about astronomy are more intelligible and arouse intrigue. People who are willing to read and learn are interested in events in disciplines like atomic physics, information technologies, biotechnology, nanotechnology, cosmology, medicine, genetics and molecular biology (of course, some arouse more interest than others …). Einstein once stated that a boring state school programme deterred him, but popular books on science opened his eyes: 'Through the reading of popular scientific books, I soon reached the conviction that much in the stories of the Bible could not be true. The consequence was a positively fanatic orgy of freethinking coupled with the impression that youth is intentionally being deceived by the state through lies; it was a crushing impression.' (Howard & Stachel, 2000, p. 37; Schilpp, 1949, p. 5).

I want to conclude my speech by listing some popular science books that I think are interesting and useful:

- Charles Darwin. *The Origin of Species*. 1859
- Albert Einstein. *Relativity: The Special and the General Theory*. 1916
- Karl von Frisch. *Aus dem Leben der Bienen*. 1927 (The Dancing Bees: An Account of the Life and Senses of the Honey Bee, 1953)
- Erwin Schrödinger. *What is Life?* 1944
- Thomas S. Kuhn. *The Structure of Scientific Revolutions*. 1962
- *Mathematics in the Modern World*. Scientific American, New York: 1964.
- James D. Watson. *The Double Helix*. 1968
- Edward O. Wilson. *The Insect Societies*. 1971
- Richard Dawkins. *The Selfish Gene*. 1976
- Carl Sagan. *Cosmos*. 1980
- Richard Rhodes. *The Making of the Atomic Bomb*. 1986

- Stephen Hawking. *A Brief History of Time*. 1988
- Richard Feynman. *Six Easy Pieces: Essentials of Physics Explained by Its Most Brilliant Teacher*. 1994.
- Jared Diamond. *Guns, Germs, and Steel*. 1997
- Bill Bryson. *A Short History of Nearly Everything*. 2003
- Carlo Rovelli. *The Order of Time*. Penguin Books, 2018.

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