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Learning from education to communicate science as a good story

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Science communicators must learn from science educators in their crusade to counteract the traditional boring and inefficient approaches to convey science. Educators encounter a need for methods of teaching that portray science as 'hard fun' and resources that encourage students' minds to burst into action. Narratives are considered by several authors as highly valuable resources for science education. However, little research has been undertaken to measure the efficiency of narratives in the context of science communication to the general public. Recent work however, suggests that narratives are indeed an alternative and an important means for science communication to convey information in an accurate, attractive, imaginative and memorable way. To present scientific information through stories, novels, comics and plays should be regarded as an important means to transmit information in the repertoire of both science teachers and science communicators.

To understand is to speculate with images
Giordano Bruno

Assuming that a particular curriculum has been chosen to improve science literacy within a given society, there are two ways of dealing with the task of its implementation. First, for those still at school, the information can be delivered through new courses of study. Second, for those for whom the educational system has already failed or who need to be brought up-to-date, the information has to be made available in other forms [1]. These other means are the ones that concern science communication.

Despite the differences between science education and science communication (audience, theme, mode of delivery, agenda and institution involved), these two disciplines have many points of connection. Their general objective – scientific literacy – is analogous, and the problems of communicating, representing and recreating science in an understandable, memorable and enjoyable way are also similar. The aim of both is to convey science; both broadly pursue the ideal of an individual armed with 'scientific method'.

Science education has been a subject of research for centuries. For science communication, it is therefore sensible to learn from the experience gained with this discipline in its attempt to help the individual to speak and understand the language of science. Furthermore, science education provides actual examples of the use of different resources and methods in the classroom. Narratives, in particular, are considered by several authors as remarkably valuable resources.

Science education

The most important starting point for improving the understanding of science is undoubtedly an adequate scientific education at school [2]. Public attitudes towards science owe much to the way science is taught in these institutions. Today, school is where most of the population comes into contact with a formal instruction and explanation of science for the first time, at least in a systematic way. It is at this point that the foundations are laid for an interest in science. What is taught (and how) in this first encounter will largely determine an individual's view of the subject in adult life [3].

One of the main concerns held by science educators is to modify students' general attitude towards science [4]. Common assertions amongst students are 'science is scary', 'it is a place of embarrassment', 'it makes people feel stupid, bad and angry'. Students also tend to perceive a huge gap between their own capabilities and the geniuses (scientists) that appear in their textbooks [5].

Understanding the origin of the negative attitudes towards science may help us to modify them. Most education systems neglect exploration, understanding and reflection [6]. Teachers in schools tend to present science as a collection of facts, often in more detail than necessary (Figure 1). As a result, children memorize processes such as the biochemical paths of respiration or the periodic table, only to forget them shortly afterwards. The task of learning facts and concepts, one at a time, makes learning laborious, boring and inefficient. Such a purely empirical approach is also, in a sense, unscientific or incomplete, consisting of observation and description, but omitting the fundamental phase of generalization [7]. There is therefore a need for resources and methods of teaching that facilitate a deep understanding of science in an enjoyable way. Science should be not only be 'fun' in the same way as playing a video game, but 'hard fun' – a deep feeling of connection made possible only by imaginative engagement [4].

Sutton believes that the materials used in a classroom should allow freedom of interpretation, so that students' minds break into action and that this will then lead to

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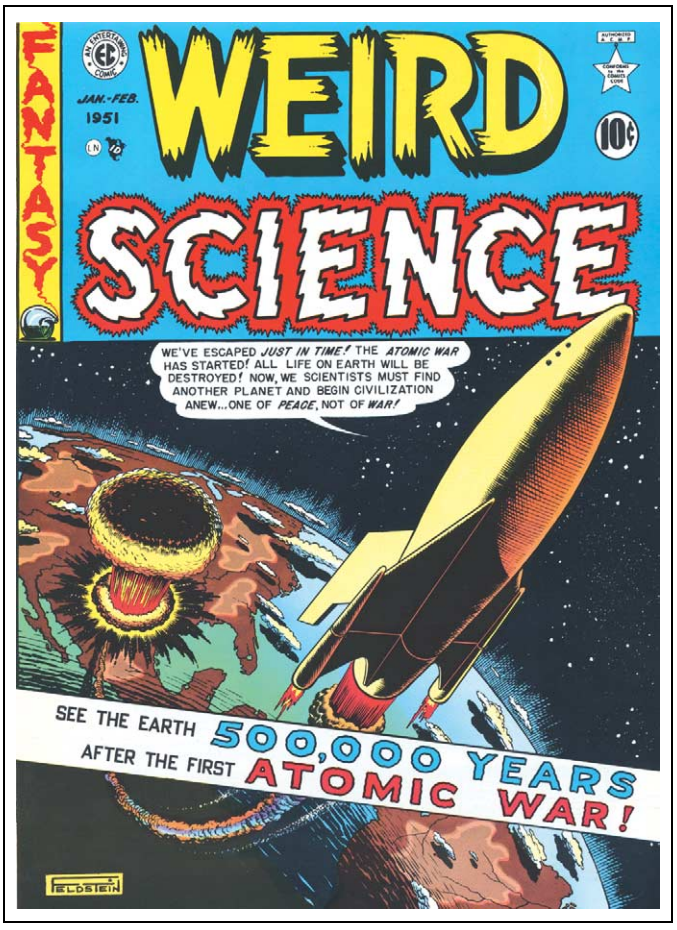

Figure 1. The cover of issue 5 of EC Comic's *Weird Science,* a small part of the explosion in the popularity of science fiction in every type of media during the 1950s. Image supplied by Gemstone publishing and reproduced with permission of William M. Gaines, Agent, Inc.

different conclusions being drawn [8]. Both teaching and learning would then involve a certain level of negotiation in the meaning between teachers and students. It is in the spirit of fictional narratives to allow freedom of interpretation, as it is the very absence of explicit spelling-out that allows the reader to enter into and engage with the story, triggering the imagination. Explicitness, by contrast, would reduce that freedom.

The value of narratives in the classroom

First, it is essential to admit that the importance of schools as transmitters of knowledge, although still foremost, has decreased in favour of mass media and entertainment technology [9,10]. Instead of denying, resisting or trying to reverse this trend, schools should encourage their students to analyse mass culture and to acknowledge its value as a form of expression [11].

The decision of favouring science textbooks and restricting the use of other media in science education must be reconsidered. Science and technology are represented in many other forms of communication such as radio, television, news, magazines, music, cinema [12–15] and a range of fictional literature, including drama. Bearing in mind that whatever pupils find pleasing, entertaining, or stimulating helps them learn more effectively [16], we have to include all of science's cultural media, in particular science fiction, science fantasy, drama and other forms of narrative that value science as a theme [17] (Figure 1). These are all cultural expressions of science in our society, are receptacles of scientific knowledge, and are important resources for science communication and education.

Narrative, as a form of art and entertainment, can foster pupils' interest in science. An advantage of scientific explanations is that their underlying structures are similar to those of a story: they include protagonists (studying electrons and genes) that enact a sequence of events with an outcome (the phenomenon to be explained) [18]. Many authors recommend using stories for science education. For instance, Solomon believes that introducing stories about the history of science would help to create a popular scientific culture that could benefit pupils understanding of the humanist nature of scientific theory, as well as various controversial concepts [19]. Solomon considers that students can also gain an acquaintance of science through narrative instead of putting the emphasis on learning precise definitions of scientific topics. Similarly, Gough [20] recommends that lessons should analyse cultural texts with scientific content, including narratives (historical accounts of scientific work, autobiographies of scientists, scientific journals and images of science in the arts and in popular media).

Stories can have a strong effect on children's interests. In fact, many scientists acknowledge the influence of narrative in their choice of career. Works by Dawkins, Gould, Crick, Watson and works of science fiction 'have fired the young imagination and left a challenging personal impression on the reader' [21].

The narrative strategies employed in fiction have been used for many years in science. Albert Einstein, for example, defended realism and relativity by describing an imaginary experiment, and it took nearly 30 years for other scientists to revert to his unsaid assumptions and predict the outcomes of feasible experiments [9]. Literary tools are the best way to describe a world in which reality exists only at the level of human experience [22]. The randomness of our world has to be acknowledged, when the most powerful concepts that humankind has come up with are non-linear dynamics, indeterminacy and unpredictability [20]. Instead of using the formal, authoritarian language of science to introduce, for instance, quantum indeterminacy, better results could be achieved through the casual conversation of a character in a novel, an example of which can be seen in *Charades* by Janet Turner Hospital [23].

Stories are easy to comprehend, as well as memorable for the following reasons: they often describe events in the order in which they occur and everyone, including children, is familiar with that structure–fictional narratives seem to encourage child participation in discussions [24]; at the same time, all the elements in a story are connected and this enables it to be appropriated as a unit of imagination [25]. It is worthwhile pointing out that several studies have showed that lower attaining students can make great progress if their imagination is stimulated [26].

Additionally, stories are a way of amplifying emotions [27]. Because the durability of a particular memory seems

to depend on how exciting the original experience was, how much attention was paid to it, and how often it is recalled, it is then reasonable to suppose that the elements of a story will be part of the long-term memory.

Another feature that makes narratives memorable is that within a story, one part evokes the next and the need for a final denouement involves the person reading [18]. The reader is captivated by the emergence of assumptions of what may come next and the elements underlying what has already been said [8]. If the stories are learned properly, they become like a familiar word, where hearing a small fragment is sufficient for 'the whole story's electric circuit to be switched into consciousness and all its light and power brought to bear' [25].

The value of using narratives in science education is related to the way in which the brain deals with this kind of information. In order to understand this process it is helpful to remember that a story is formed by its pattern and images. The brain uses the pattern of one set of images to organize another set. It also uses one image, with a few differences, as an arrangement for meanings that would otherwise be imageless. Consequently, stories not only light up all the relevant elements in our own experience, but they also improve our understanding [25].

One way of visualizing the advantages of narratives is to compare their impact to that of traditional textbooks. Whilst narratives keep the reader interested, partly because they leave some room for doubt and imagination, textbooks are seen as an authority, and aim to leave no room for ambiguity [8]. Additionally, when stories are used as learning aids in the classroom, the lesson is still in the hands of the teacher; however, when textbooks are used, the lesson is not owned by the teacher but by the author of that textbook [24]. As Sutton states [8], the two types of reading material can exist side-by-side: one encouraging the exploration of scientific ideas (narrative), and the other being used to form a reliable quick guide to their structure (textbooks). This suggestion derives from Sutton's point of view about ways of using language.

There are two purposes for using language, he argues – to interpret and to label. When the writer is conscious that there may be some doubt in the interpretation of the words, they must be chosen with the greatest of care. This way of using language occurs when the purpose is to explore, to understand, to teach, to persuade or to suggest. During this process, thought and dialogue are being steered in a particular direction, giving the reader freedom to interpret the meaning of the text [8].

However, when the relevant words are readily available to the writer, language is used in a labelling way for instance, current use of the words 'cell', 'atom' and 'electron'. Textbooks generally use labelling language in an attempt to transmit clear and unambiguous meaning [8], as they are not aiming for freedom of interpretation. By contrast, it is reasonable to believe that narratives tend to include interpretative language, consequently enhancing reflection and dialogue in the reader.

On the road to storytelling in science communication

In short, the following points made by science educators are particularly helpful for science communication: science should be presented as entertaining (science fun), but in the sense of having a deep connection with the subject [4]. With regards to the use of resources, it is of paramount importance to include alternative forms of expression that permit freedom of interpretation, so that students can draw different conclusions [8]. Different media must be used because it has been proven that we as individuals all learn in different ways: visually, by auditory means, through touch, kinaesthetically. Examples of these are mass media and narratives. The former can be the object of analysis in the classroom and narratives can be included as reading material, in addition to traditional textbooks. Teachers would then

Figure 2. H.G. Wells was a science-fiction writer who was also a scientist. More than perhaps any other piece of science fiction, his novel *War of the Worlds* has been translated in to different media. From left to right: the cover of the original 1892 edition of *War of the Worlds*. Reproduced by, and printed with permission of, The British Library. The arrival of the Martians on Horsell Common is depicted in the illustrations that accompanied Jeff Wayne's musical adaptation of the story. Reproduced with permission from Sony Music (UK) Ltd. The Martian attack on Earth was also adapted in comic form, one of several versions appearing in issue 14 of *Marvel Classic Comics* in 1976, reproduced with permission from Marvel Enterprises Inc.

use: (i) narratives and (ii) mass media, which encourage exploration of scientific ideas and (iii) textbooks, which can serve as quick guides to their structure.

Storytelling is an amusing way to create an interest in science. Narratives are attractive and memorable; their structure is familiar to children [24]; they involve the reader in their need for denouement [18], and use an interpretative language, which encourages thought and dialogue [8]. Also, they liven up the imagination, which in turn has proved to facilitate the learning process [26].

The evidence provided by science education suggests that narratives play an important part in a teacher's repertoire and that this medium has been used successfully in the classroom to convey scientific knowledge in an accurate, attractive, imaginative, participatory and memorable way.

Although, as previously mentioned, there are important differences between science education and science communication, the problem of representing and recreating science in an understandable, memorable and enjoyable way is a common concern for both disciplines. Science communication should take note of the experience gained in the use of narratives in the classroom, and should start to consider these means of communication as an important resource to communicate science, not only to children, but also to the general public.

A variety of authors have in the past made successful incursions into science communication via narratives, generating an important impact in the general public perception of science. Examples are H.G. Wells (Figures 2–4), Edwin A. Abbott, Arthur Conan Doyle, Primo Levi, George Gamow, Lewis Carroll and Anatoly Dnieprov.

According to Sanchez [28], popular science writing from the second half of the 20th century shares the common belief that the literary aspect of the text is one of the fundamental postulates for this discipline. In doing so, it stops being a subsidiary discipline of science and becomes instead a creative and autonomous discourse about science, parallel to science itself but with different intentions. There is a new generation of science communicators who incorporate narrative, fictional and imaginative elements in their work, offering the general public an attractive and safe passage to scientific knowledge. Examples are Italo Calvino, George Perec, H.G. Gould, William Gibson, Simon Singh, Caryl Churchill, Michael Frayn, Tom Stoppard and Deborah Levy.

The above illustrations of novels, short stories and drama with scientific content show that a good effort has been made to produce such materials for science communication, but how much is the public actually learning from these narratives? This is an important question, which needs to be addressed.

Interesting experience and evidence have emerged from science education on the use of narratives in the classroom, but little has been done to evaluate narratives in the context of science communication to the general public. Recent research however, explored the role of narratives as a means of communicating scientific ideas to the general public [29]. The objectives were to measure the success of a fictional literary work in communicating scientific ideas – how much science can be understood and remembered when it is included in a short story compared with science conveyed through traditional factual text and what are the motivational dimensions of literary stories as tools for communicating science?

This research study concluded that participants were able to identify and remember, with varying degrees of accuracy, the scientific information contained in the stories. Moreover, some were able to apply and extrapolate on the information provided in the stories. Scientific information, it seems, is better remembered immediately after reading a list of facts than it is after reading a story. However, as time goes by, there is no statistical difference in the amount of scientific information retained comparing the two formats. Consequently, it is possible to conclude that both text forms are equally effective in conveying scientific knowledge with the only distinction, made by the participants, that narratives is a more attractive and enjoyable way of learning such information.

Narratives are an alternative and an important means for science education and communication. They may provide an accurate way of representing and communicating knowledge, an effective emotional trigger, a lasting memory structure, an enjoyable medium and a powerful

Figure 3. Various interpretations of *War of the Words* in different media. From left to right: In the PC game released in the Mid-1990s gamers were given a chance to take control of the action and either attempt to conquer Earth or repel the Martian invaders. Gene Barry, Ann Robinson and Les Tremayne shudder in the face of the seeming unstoppable nature of the Martian's assault in the 1953 Paramount adaptation of *War of the Worlds*. Image supplied by and reproduced with permission of MPTV.net. However, the Martians were not invincible, and died once they contracted the common cold as depicted in another of the illustrations that accompanied the musical version of the story. Reproduced with permission from Sony Music (UK) Ltd.

Figure 4. The popularity of *War of the Worlds* is a strong as ever, which led Sony to release a cutting edge version of Jeff Wayne's musical adaptation at the beginning of the 21st century. Reproduced with permission from Sony Music (UK) Ltd.

aid for learning. To present scientific information through stories, novels, comics and plays should be regarded as an important means to transmit information in the repertoire of both science teachers and communicators. As more communicators turn to narratives to explain contemporary scientific issues, it is reasonable to expect that the evaluation of this means of communication to the general public will become a more systematic endeavour.

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