False Friends: What Makes a Story Inadequate for Science Teaching?

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ABSTRACT: Recently, an emphasis on the potential and advantages of stories and narratives in teaching situations can be observed in discussions on science education. From this, one might conclude that just starting to use stories in science classrooms is a good thing *per se*. Yet, as I will argue in my paper, things appear to be not that easy. From my understanding, it is necessary to select the stories to be told in teaching situations with care—and also to select those stories which are not to be told. With respect to such a selection, different criteria can be employed, depending on the aims of the instructional episode. In doing so, my criterion of selection will be based on an education which does not focus solely on the communication of scientific knowledge but which emphasizes topics from the nature of science as relevant criteria for structuring the teaching. With this intention, one can identify constructions of narratives that are misleading with respect to the nature of science and which may lead to an inappropriate understanding of science and scientific practice.

KEYWORDS: Science stories, criteria for using in teaching.

Introduction

I begin with a disclaimer: Stories are useful for science teaching. This is something I would not put into question. Yet, this statement appears too simple and general to me, as one could (and should) ask what kinds of stories are useful for what kind of science teaching; and one should also add the question, "for which students are these stories useful?". In answer to this question, in this paper I am only discussing the utility of stories for science education of students aged 5-15. This limitation is necessary, as I am referring to an education which is compulsory. Moreover, my discussion is limited to science classes; I am neither discussing the potential benefits of history of science in a history classroom, nor the potential of implementing history of science as a topic by its own right. Consequently, when

referring to stories, it is not necessarily an adequate question for discussion in this paper as to whether these stories are historically adequate narratives of events from the past or simplified anecdotes or even totally fictional.

Taking these aspects into consideration, I could narrow the topic of my contribution down to the question of what stories could contribute to science education at school level, or, referring to the call for papers for the *Second International Conference on Stories in Science Teaching*: "… how can they [stories, PH] contribute effectively to student learning in science and mathematics" (Klassen & Teichmann, 2008, 1). Taking this statement literally, two questions could be asked:

- Why are students supposed to learn in science and mathematics?
- What are students supposed to learn in science and mathematics?

Two legitimizing aspects of science teaching

When looking at governmental documents, as well as discussions from science didactics, two aspects are frequently pointed out in favor of compulsory science education. One argument is a political one that can be summarized as follows: students are to understand that science plays an important role in our modern society. In order to participate in political and social decisions, a fundamental understanding of science, as well as the nature of science, is desirable. This is relevant in discussions of impacts, potential benefits, and risks of new technologies and scientific developments, but also of actual problems and difficulties. Examples could be the discussion of stem cell research, the use of nuclear power, and the potential risks of cell phones (and the related aerial masts).

The second argument is an economical one. Society has a need for scientists and engineers; consequently, science teaching should encourage students to take careers in these fields into consideration. This argument can also be expanded to the individual situation—persons who are qualified in the sciences normally have a higher income than persons who do not have these qualifications. Particularly in a country like Germany, politicians are frequently pointing out that scientific literacy is among those resources that are vital to the economy and should thus be increased.

Taking these political legitimatizations into consideration, it becomes clear that a major task of a compulsory science education on school level is not the accumulation of scientific knowledge but an

understanding of the nature of science as well as procedural knowledge. Consequently, inquiry-based approaches have become increasingly popular in the discussion. Yet, the question whether stories can contribute to these approaches has not entered my analysis. I will focus, in what follows, on potential contributions of stories with respect to an understanding of the nature of science by students, or, to be more accurate, my focus will be on potential discrepancies between the understanding of the nature of science and the image of science produced by stories.

Stories and the nature of science

The nature of science has been one of the dominant aspects in the didactical discussion of the past two decades. In this respect, the collection of contributions edited by McComas has certainly been very influential. In particular, the table showing the "consensus view of the nature of science objectives extracted from eight international standard science documents" (McComas et al. 1998, p. 6) has been prominent and discussed frequently. In the following, I am going to use this list and will contrast certain of its arguments with science stories, thus showing that these stories are not necessarily adequate for achieving a better understanding of the nature of science.

"Scientific knowledge, while durable, has a tentative character." (McComas et al. 1998. p. 6)

Here, the problem is very straightforward. Most stories focus on successful scientists and their achievements. Only very few discuss knowledge that has been overthrown. From my understanding, there are several reasons. On the one hand, there are historians (and scientists) who focus more on successful researchers and their achievements than on the ones whose findings were not accepted or overthrown. Thus, one could argue that the 'symmetrical approach' formulated by Bloor (1991) for the field of science studies has not been realized in stories for science education yet, even though there are several examples of studies which focus on unsuccessful researchers (see e.g. Frercks, 2007; Heering, 2006; Nye, 1981; Holton, 1978).

Yet, it is not only a problem of adequate material from the history of science, as most educators feel that they are under a strong time pressure and are hardly able to discuss everything in their curriculum. Consequently, they are hesitant to implement materials in their courses that are not directly related to this curriculum. This could already become a problem for the acceptance of stories in

science education *per se*. In any event, it appears to be very difficult to convince teachers to use stories that focus on unsuccessful researchers or approaches and concepts that are no longer considered to be a part of the science syllabus.

"People from all cultures contribute to science."
(McComas et al. 1998, p. 7)

When looking at stories that are suggested for science education, it is evident that most of these stories focus on European or North-American scientists. Thus, the image is generated that science is a European / North American enterprise, and, in some sense, this image is not completely wrong. What we nowadays consider to be science has its basis in a European way of describing nature during the 16th, 17th, and parts of the 18th century, and only in the second part of the 18th century did North Americans begin to be involved in this process. However, these developments did not appear out of nothing but are based on contributions from ancient cultures. During the 19th and most of the 20th century, almost each researcher that could be labeled as a scientist came either from the European or from the North American culture group. At least this is the standard story that is told in most history of science textbooks. Yet, taking a closer look reveals two aspects. Persons from other cultures participated in scientific research, and other cultures had also achievements in describing nature, even though their concepts were different from Western science. Consequently, the stories discussed in an educational context seem to be too narrow to contribute to this aspect. However, this situation does not seem to be changed easily. It is not only a problem of preparing adequate stories. From my perspective, the problem lies, at least partly, in the teachers' perspective of the curriculum. According to their understanding, most scientific achievements that are to be discussed on school level are related to European researchers. Consequently, they do not see the potential of discussing contributions of other researchers. This may also be related to another aspect which forms another problem for the use of stories in science education, namely, social and cultural traditions.

"Science is part of social and cultural traditions."
(McComas et al. 1998, p.7)

Most students are unfamiliar with social and cultural traditions different from their own; moreover, classes frequently have no coherent cultural background. Consequently, to make transparent to the students the links between science, on the one hand, and social and cultural traditions, on the other, they have first to get an

understanding of the background. Developing such an understanding gets even more difficult if the group is incognizant of the individual cultural background of the students. It appears questionable whether science teachers are able to communicate such a background to their students unless it is one that is not too distinct from the expected one. This may also serve as an explanation of the focus on European centered stories; their cultural background appears to be fairly familiar (at least to the teacher).

"Scientists are creative." (McComas et al. 1998, p. 7)

There does not seem to be a problem with this aspect, as the creativity of a scientist could be relevant to a good storyline. However, if we are looking at examples of stories that are told and where creativity plays an important role, we easily find examples such as "the true story of a lone genius …". From a historian's point of view, the phrase 'true story' should ring a warning bell, however, that is beyond the scope of this discussion.

From my understanding, the problem for educational purposes lies in the formulation of the 'lone genius'. If such a role model is transported through these stories, a problem occurs from the perspective of science education, namely, "who wants to be like that?". Students, certainly, do not want to be lone (meaning non-social) persons and they usually do not consider themselves as geniuses. Actually, we have some empirical evidence that some students, particularly in their adolescence, tend to lose their initial interest in the sciences due the incommensurability of the image of scientists with their self-image (see e.g. Hannover & Kessel, 2004).

One aspect with which to overcome this difficulty lies, of course, in the manner in which these stories are told. As Klaus Hentschel has demonstrated convincingly, the story of a lone genius is one of the classical myths in the history of science. Most scientists had assistants, instrument makers, or other collaborators who were equally important for the success of the project. Consequently, science becomes a social enterprise with different actors and different skills. Yet, historians of science tend to focus only on the seemingly central person, researchers such as Robert Boyle, James Precott Joule, J.J. Thomson, or Ernest Rutherford. However, their experimental success relied strongly on collaboration with Denis Papin, J.B. Dancer, E. Everett, and W. Kay, respectively. But even if more differentiated accounts are used as the basis for stories of science, a major problem remains, namely, that all the actors are male, and female students may not be able to identify themselves with male role-models.

There are also some other problems with stories providing stereotypes of scientists. Several anecdotes exist about the "weirdness" or even inability of researchers to get along in everyday life. For example, Joule, being on a honeymoon with his wife in Switzerland and, when visiting a waterfall, tried to determine the rise of the water temperature due to its fall (Cardwell 1989, 89, suggested that this story was fabricated by Kelvin). Ampère has been described by "his rotten teeth, his less than modish wardrobe, and his awkward bearing in society" (Hoffmann 1996, 30). And, probably, everyone has heard one of those anecdotes about Einstein being totally impractical and confused.

Anecdotes like these may be entertaining and even motivating; yet, the problem remains that scientists, when caricatured as impractical, weird geniuses, cannot serve as role models. Although these stories might provide some entertainment for students, such an approach with stories in science teaching will probably not result in recruiting these students into science courses at university level. But it is not just the negative image that may result in problems; one can also question whether students can identify themselves with scientists who are described as geniuses. In this respect, taking the Nobel Prize as a criterion for selecting a scientist appears to be, at least, problematic. Nobel Prize winning scientists are considered to be exceptional. Therefore, it seems to be questionable whether they can serve as a role model for high school students.

Conclusion

Several conclusions can be drawn from this discussion. One could, of course, argue that stories are an inadequate teaching tool in compulsory science courses. Yet, this would completely miss my point. From my perspective, the problem with stories appears to be twofold—on the one hand, many stories can create a misleading understanding of the nature of science—on the other hand, stories can create an image of scientists that contradicts the self-image of students and, thus, may have an unwanted impact on career decisions. The consequence should be to choose the stories employed in teaching situations, carefully. In the following, two examples of potential stories are sketched that could be used in teaching without having the deficits discussed in the earlier examples.

The first example is actually not a single story, but rather a narrative that consists of several stories. They have in common that they are situated in the second half of the 18th century and played a role in the development of electrical research. An important aspect of

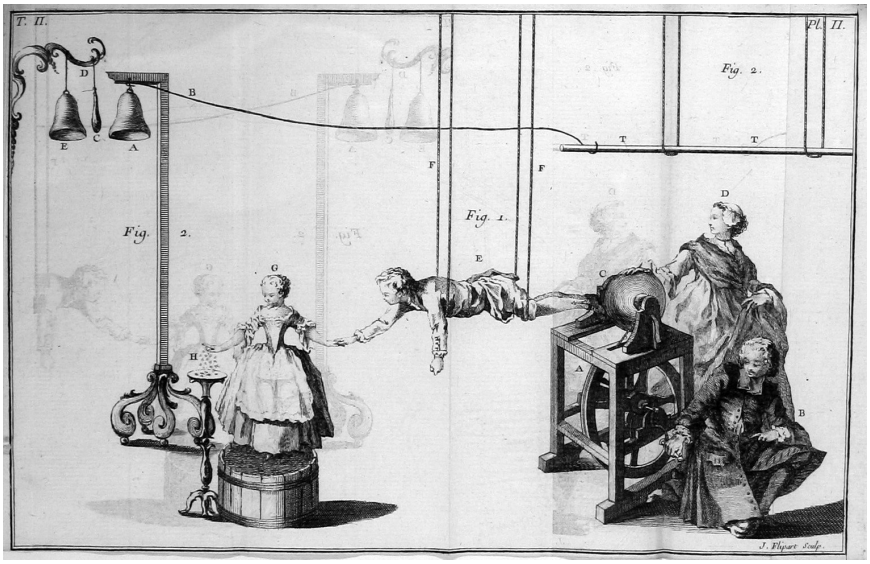

Figure 1: Electrical Experiments in Watson (1748), (with permission of The Bakken: A Library and Museum of Electricity in Life Minneapolis, MN)

these stories would the cultural background; they are situated in the European Enlightenment. Moreover, the stories are not narratives in the classical sense but actually told through images from 18th century publications. These stories could focus on public experimentation (see Fig. 1), the electrical ignition of alcohol (see Fig. 2) or the discharge of the Leyden jar (see Fig. 3, for a discussion of teaching experiences with such an approach see Heering (2000)).

These images have several aspects in common: The cultural background can be inferred from the clothes of the actors, the procedures are easy to develop, experimenting takes place in a public room, the experimenters are lay persons, and women play an active part in two of these experiments. Consequently, several of the aspects that were discussed in this paper can be identified in these 'stories'. Yet, they would still be European centered; therefore, a second exampled should be sketched. This story took place in Tanzania in the 1960's:

> Whilst making ice-cream at school with fellow students, Erasto Mpemba placed a hot mixture for making ice-cream into a refrigerator even though he was supposed to wait for it to cool. He placed his mixture next to that of a student that had not used

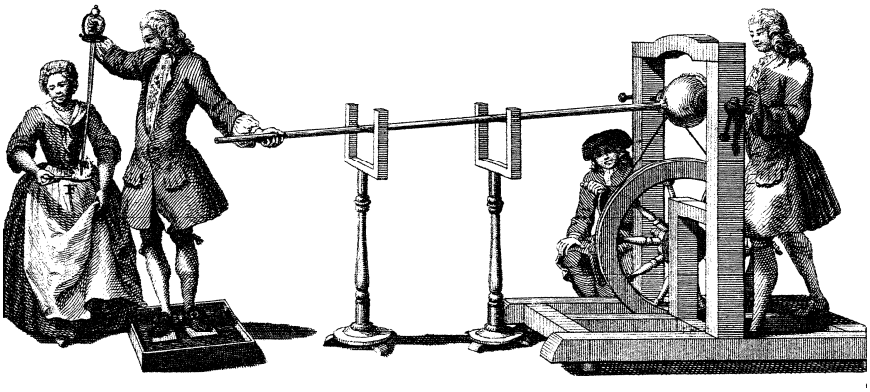

Figure 2: Electric ignition of alcohol (from Desaguliers 1751, silhouetted), (with permission of the Landesbibliothek Oldenburg)

> boiling milk whilst rushing to ensure that he would get his into the fridge before space had run out. Later on, when he returned, he noticed that his mixture had frozen first. When he asked his teacher about what he had seen his teacher then said he must have been confused and that it couldn't freeze faster. However, Mpemba decided to do his own experiments with both milk and water and continued to see similar results. When a professor from a nearby university, Dr. Osborne, came to visit the school, Mpemba questioned him about what he had seen. At the time, Osborne was unable to give an explanation for the effect but when he returned to the university he asked one of the technicians to try the experiment and report the results. "The technician reported that the water that started hot did indeed freeze first and added in a moment of unscientific enthusiasm 'But we'll keep on repeating the experiment until we get the right result' " (Mpemba & Osborne, 1969, p. 174). When Dr. Osborne continued to get similar results, he and Mpemba together published the paper from which the above quotation is taken. When it was published in *New Scientist*, readers began to write in support of this claim with other stories. (http://www.lancs.ac.uk/ug/thompsom/, last access March 23rd, 2009)

A story like this appears to be well-suited for teaching the nature of science. There is a non-European cultural background and there is a scientific effect that can be reproduced easily and poses open questions. Moreover, the effect is still not completely understood. This

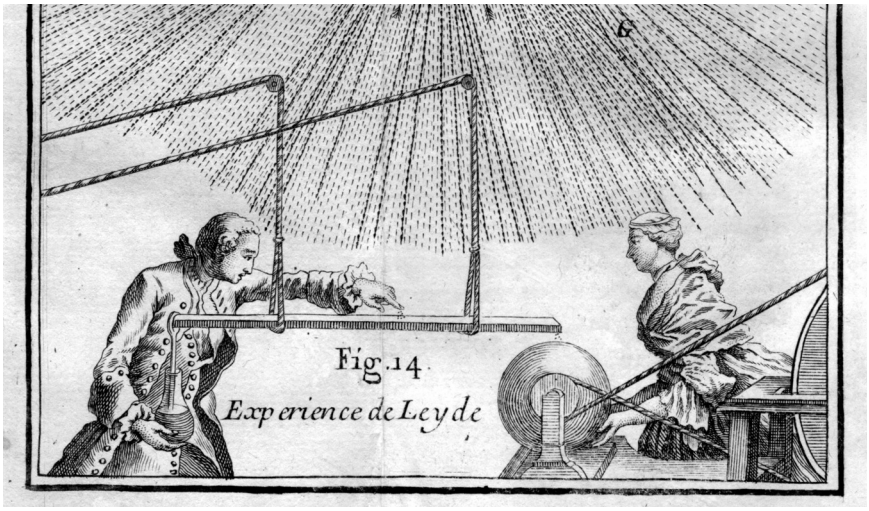

Figure 3: Discharge of a Leyden jar through a chain of persons (from Nollet 1753, with permission of The Bakken: A Library and Museum of Electricity in Life, Minneapolis, MN)

may sound as a deficit of the story, as the scientific content probably goes beyond the scope of compulsory science teaching. However, this can be used to illustrate that science is not just a body of solidified knowledge but an open enterprise to which contributions are still possible and necessary. In this respect, implementing the story of the Mpemba-effect in a unit on thermodynamics could be useful with respect to teaching the nature of science. Yet, there is another aspect which makes this particular story a very powerful one for science education. The protagonist is a school student. Thus, the students in the classroom can identify themselves with him. It may look as if this story is perfect for being used in educational situations; however, it is not, as there is a gender aspect.

Like in every other teaching situation, one has to take into consideration all the materials that are being used in a classroom. In this respect, stories can fulfill an important role in science teaching by addressing aspects from the nature of science. However, these stories have to be well chosen, otherwise, they might turn out to be entertaining but, at the same time, counterproductive to the desired focus of science education.

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