Crossing the Gap

Goethe, Wittgenstein and Science Education

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Introduction

Science educators sometimes speak of a *gap between the lived world and the scientific world* that needs to be bridged when learning science. In doing so, they make use of a common metaphor for learning. However, the metaphor can be interpreted in different ways and these different interpretations can be used to distinguish different pedagogical approaches. This is possible because the different strategies of dealing with the gap are usually a manifestation of a fundamental aspect of a particular worldview. In this essay I will propose a strategy for overcoming this gap based on phenomenological reflections. Instead of a discussion of how to build a bridge from one side of the gap to the other I will argue for a method that prevents the gap appearing in the first place. In doing so, I will also touch upon a few consequences of Goethe's scientific work that exist in the contemporary phenomenological tradition in science education. Thus this essay is also a comment on Goethe's scientific method.

Two Strategies for Crossing the Gap

The metaphor mentioned above was often used by the German science educator Martin Wagenschein (1896-1988). Wagenschein not only worked as an education researcher in the field of science didactics but was a passionate school teacher of physics, mathematics and geography. He is known for his concept of *phenomenon based learning* in science and mathematics (see e.g. Wagenschein & Berg). In his book *Die pädagogische Dimension der Physik* he states that "the gap between the lived world and the scientific world is neither justified by the nature of physics nor the nature of the child, but rather must probably be called a historical accident" (Wagenschein, 109).[1] By "gap" he means some kind of metaphorical gorge that separates the students' lived world from the experts' scientific world. This gap hinders students' access to scientific content and therefore needs to be bridged. Although it indicates a direction for research, as it stands the metaphor is still too vague; it can be used to describe almost any modern educational programme. Thus, in order to inform teaching practice, the metaphor must be specified more precisely.

One way of specifying the metaphor can be demonstrated by considering the *Model of Educational Reconstruction* (Duit et al.), which is a method for developing lesson content. According to this method, the ideas of the experts and the students are placed in a common context. This leads to the development of a curriculum that goes far beyond the subject matter of the specialist subject. The two basic components of the method are *Clarification and Analysis of Science Content* and *Research on Teaching and Learning*. These two components depict the two different worlds in the metaphor of the gap. The third component, namely *Design and Evaluation of Teaching and Learning Environments*, leads to the building of a bridge. In this specification of the metaphor, the existence of the gap between students and experts is accepted and the didactic task is thus conceived to consist in *building a bridge between the two sides*.

There is, however, another way of specifying the metaphor. Instead of bridging the gap we

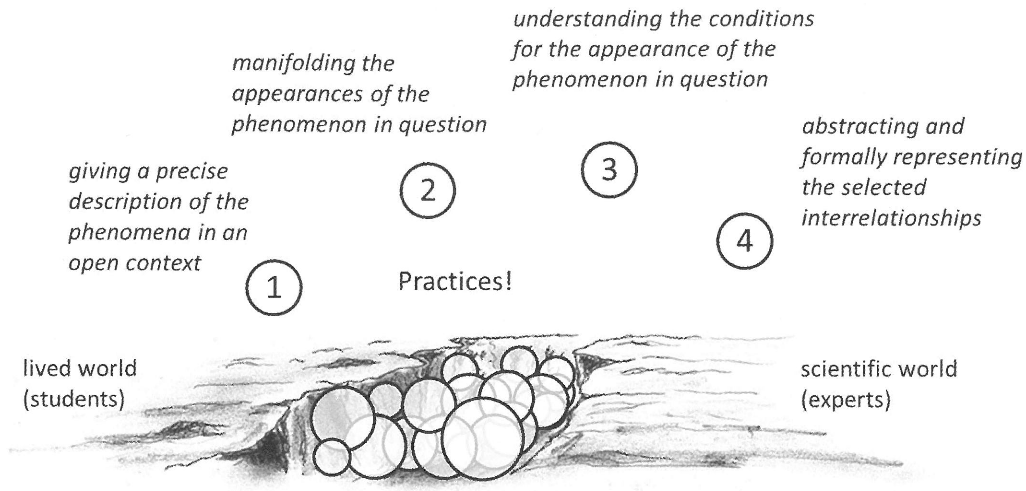

Figure 1: The phenomenological four-stage method to cross the gap between the lived world and scientific world (Müller 2017).

could *avoid its emergence* in the first place or *make it disappear* once it has emerged. On this view, the emergence of the gap is due to how the experts do science (e.g. with a tendency towards reductionism). Thus, it is clear that first of all we have to deal with the gap at the level of the experts – i.e., before we deal with it on the level of the teachers. The work of the experts should be done in an alternative way such that the gap does not even arise – neither for the experts, nor for the teachers and not even for the students. There is, however, a problem with this demand: it is a dangerous one! The danger comes from the idea that an alternative way of doing science leads to an alternative science. Whatever we do, however, should not lead to *alternative science*. We need neither to retreat from the modern age nor to develop a sociology of science or some kind of phenomenology of nature's consciousness. On the contrary, whatever we do needs to remain explicitly scientific.

These challenges echo methodical considerations in Wagenschein as well as in the fields of *phenomenology* and *phenomenon based learning*. The intention of Wagenschein, who clearly had no interest in teaching an alternative science, was that "this gap [...] *does not arise at all*" (Wagenschein 1995, 109). [2] The authors of a very profound review article on *Doing Phenomenology in Science Education* state that the question of how to cross the gap is "the common core of phenomenological critiques of mainstream science education" (Østergaard, Dahlin & Hugo, 112). One could say that the central issue of phenomenology in science education is to show a path from one world to the other without a gap. Nevertheless, Østergaard, Dahlin and Hugo – and even Wagenschein himself – explicitly talk about building a bridge: "The general and prevalent concern for almost all of the studies reviewed is the question of how to help students bridge the gap [...] between the lifeworld and the 'science world'" (ibid.). These phenomenological ideas will bear more fruit if we take the challenges mentioned above seriously and interpret them in light of the second strategy, in which "bridging the gap" becomes "preventing the gap".

Overcoming the Challenges

To understand what it means to prevent the gap requires further investigation. Within phenomenology in science education three traditions can be identified: Goethe's *phenomenology of nature* in Waldorf education, Wagenschein's *phenomenon based learning* and Husserl's and Merleau-Ponty's *philosophical and anthropological phenomenology*. The third tradition is typically concerned with the foundations of science and usually treats natural phenomena as the content of consciousness. This third tradition will not be discussed further here.

The first and second traditions, on the other hand, specifically treat natural phenomena as phenomena of nature and thus usually do their research in terms of science. A review of the contributions from these two traditions shows that the practitioners are less concerned with pointing out a way to bridge the gap *as a whole*, but rather concentrate on two separate aspects of the long path (see Müller).

The contributions of the Wagenschein tradition show a special interest in the games students can play in order to get to know nature and develop teaching concepts that point from inside the lived world of the students out in the direction of the scientific world. They provide countless examples of initial variations (simplification, intensification, etc.) of phenomena.

For example, in the phenomenological teaching of reflection, much time is spent on getting to know what is seen in the mirror (Schön). Such questions are explored as: Where are the objects seen in the mirror located spatially? How do the boundaries of shadows behave? How can distances be measured in the mirror? Step by step, the use of mirrors is explored until finally the concept of a "mirror-space" is developed.

Contributions based on the Goethean tradition, on the other hand, show special interest in the conditions under which phenomena appear and treat the subjects that lie between the lived world and the scientific world. On the basis of further variation or "manifolding", they attempt to understand the *conditions of appearance* of the phenomenon in question. "*Manifolding*" does not just involve a multiplication of phenomena, it also involves placing "side by side what in fact is side by side" in a series that links distant phenomena with each other (Goethe).[3] For example, when examining the rainbow, instead of jumping to an examination of light rays, the first question asked is simply what can actually be seen in the falling, brightly coloured raindrops (Müller & Grebe-Ellis).

However, in identifying the two traditions described above, a third approach can also be identified. Starting from other phenomenological studies, contributions based on this third approach aim to develop transitions from understanding the conditions for the appearance of phenomena to the scientific world (e.g. Grebe-Ellis; Quick; Rang). The result is a methodology consisting of several stages, which not only allows the gap to be crossed, but even makes it disappear. This *phenomenological four-stage approach* is shown in figure 1 (Müller).

A feature of the phenomenological four-stage method is the transition from the first step to the third. When we carefully describe the phenomena created by "manifolding" a phenomenon, we learn new *practices in dealing with that phenomenon*; for the "manifolding" of phenomena goes hand in hand with the increase of practices. These new practices are not simply carried out; they must first be adopted – they must be found and invented.

This methodological feature is hard to distinguish within the phenomenological traditions and so a point of view from outside the traditions is needed. Following the praxeological view developed by Ludwig Wittgenstein in philosophy of language (Wittgenstein; Kogge), these practices can be described as *science games* analogous to Wittgenstein's *language games* (Müller 2017). Science games mediate between the everyday practices of life and the elaborate practices of science. They fill the gap. And, moreover, they have a place in the history of science and are therefore not an alternative to science. Science games are those practices that were developed in the early stages of an area of science through *explorative experimentation* (Ribe & Steinle). Explorative experiments are typically found in situations "in which there is uncertainty on a fundamental conceptual level, i.e. in which, under whatever circumstances, not only specific theories but also established systems of concepts, ways of thinking and means of representation are shaken in their reliability" (Steinle, 20).[4] As soon as the uncertainly is overcome by explorative experimentation, the tendency towards exploration decreases and with it the willingness to practice such science games. The diversity of what was discovered is gradually forgotten and a gap opens up between the lived world and the scientific world.

Crossing the Gap by Filling it

With the phenomenological approach, especially with the associated "manifolding" of phenomena, the expert is not concerned with developing an alternative science. Instead, the history of traditional science is recovered or recreated. The practices introduced here as "science games" play a special role: they fill the gap between the lived world and the scientific world and thus make it disappear. A central concern of educators in the area of phenomenology in science education is to show a path from the lived world to the scientific world without a gap. With the approach described here, students are lead neither down a steep path to the bottom of the gorge, nor across a bridge over it. Rather they are lead along the level ground from the lived world to the scientific world. The grounds on which they walk are science games.

Notes

1 The English translation of the title is: "The Educational Dimension of Physics". The cited passage is my translation.

2 Emphasis in original; my translation.

3 English from G. Adams' translation of Goethe's essay *Experiment as Mediator between Object and Subject*, page 131.

4 My translation.

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